

Integrating the semantic wiki approach to face to face courses

A case study on theoretical computer science

Germana Nóbrega¹, Fernanda Lima², and Dayane Freire³

¹ Universidade Católica de Brasília, Brazil, gmnobrega@pos.ucb.br

² Universidade de Brasília, Brazil, ferlima@cic.unb.br

³ Universidade Católica de Brasília, Brazil, dayfreire@gmail.com

Abstract: Within the context of theoretical Computer Science, Formal Languages and Automata (FLA) courses usually include constructions often limited to small examples. In a hands-on approach, automata editors/simulators allow students to work in a more attractive way. Such tools, however, do not embed domain knowledge nor do they promote collaborative learning. In this paper, we present an educational setting exploiting the approach of Semantic Wikis, along with a real use case aiming at contributing to a better understanding on how semantics arises from end-users collective editing, and how this can improve learning.

Keywords: Formal Language and Automata, Semantic Wiki, Semantic Annotations, Collective editing.

1. Introduction

The study of theoretical computer science and, in particular, formal languages and automata (FLA) is relevant within Computer Science (CS) and several engineering curricula for a number of reasons. Examples include understanding the principles of compiler construction, learning how to read and to represent markup or programming languages under the form of grammar rules, or yet regular languages under the form of regular expressions, which are present in almost all high-level programming languages nowadays. In addition, studying FLA is relevant for the understanding and development of algorithm reasoning skill as well as for understanding the notion of computability. These are benefits usually coming

from the handling of abstract state machines, ranging from finite automata up to Turing machines.

In spite of the above mentioned relevance of theoretical CS, the number of initiatives in terms of computational support to help in its teaching/learning process remains modest. Let us mention one project of increasing great impact worldwide, the editor/simulator JFLAP¹, leaded by Susan Rodger and her team for more than one decade now. In [1], the authors point out to one difficulty in teaching formal languages and automata on traditional approaches, as they include construction exercises that are often limited to small examples. They argue that “even on a moderate-size example of constructing an automaton [...], students are unlikely to do much testing as it is tedious to trace by hand” [1]. Their JFLAP tool appears to provide a hands-on approach to FLA courses, having the advantage of focusing on a wider number of topics, when compared to other tools for handling the domain.

A pioneer Intelligent Tutoring System (ITS) appearing in the literature for teaching formal languages and automata is FLUTE [2]. Motivations for the design of such ITS also relies on the relevance of the domain, the lack of learning environments reported in literature, and, from a pedagogical viewpoint, student’s needs to work this discipline in a more attractive way, as they connect abstracts concepts to their practical applications. Based on a framework called GET-BITS, the architecture of the system includes an expert module, a student model, a pedagogical module, and an explanation module. An important feature we highlight within the work is the authors’ concern with motivation, as “the system tries to increase the learner’s interest for further study of related topics”.

We see the two above mentioned tools as complementarily suitable to help in FLA courses. While JFLAP has proven to improve learning by its micro-world approach, the ITS architecture provided by FLUTE aims to guide students along their individual study. However, on the one hand, none of the tools offer any support to collective activities. On the other hand, in the case of traditional ITS, the domain ontology is usually built and maintained off-line and by a domain expert. In this paper, we focus on the setup and the use of a Semantic Wiki as part of the methodology of a FLA face to face course. From a research viewpoint, our aim in leading this study was to investigate the benefits from the social aspect provided by the Wiki approach when combined with the strategy of on-line and student built domain ontology. In section 2 we progressively present the Semantic Wiki approach in education. In section 3 we introduce the case study. Section 4 closes the paper.

¹ <http://www.jflap.org>

2. From Wikis to Semantic Wikis in Education

Wikis are initiatives about the collective organization of non-structured information on the Web that are widely used by domain experts. The first Wiki (WikiWikiWeb) was conceived by Cunningham in 1995 as a freely expansible interconnected collection of Web pages, a hypertext system to store and modify information - a database, where each page is easily editable by any user that has access to a Web browser capable of dealing with forms [3]. In [4], the authors mention a variety of uses for Wiki systems, such as: encyclopedia systems like Wikipedia, coordination in software development, project management, personal knowledge management and collaborative writing.

A Semantic Wiki is a Wiki with augmented functionalities based on Semantic Web technologies, which provides more knowledge than simple structured text and links without meaning. Usually the additional knowledge is made available through the use of formal languages, allowing inferences of new facts based on the ones represented in the knowledge model. This formal knowledge allows more efficient searches compared to syntactic searches using keywords. One of the differences between Wikis and Semantic Wikis lies in what can be formalized. In the case of Semantic Wikis, it is possible to create types for pages, categories and links.

A number of Semantic Wiki tools have appeared in the literature in the last few years. Let us highlight Semantic MediaWiki [5], an extension of MediaWiki (the free software that powers the well-known encyclopedia Wikipedia), a semantically enhanced wiki engine that enables users to annotate the Wiki's contents with explicit, machine-readable information. As MediaWiki and Semantic MediaWiki become increasingly used world-wide, the development of extensions has been considered in research projects for a variety of purposes. One such extension is carried out within the Halo project in order to facilitate the use of Semantic Wikis for a large community of users².

Another popular Semantic Wiki is IkeWiki (c.f. [4]), originally developed to support knowledge workers in collaboratively formalizing knowledge. Some of Ikewiki's features include friendly interface, which tries to get close to Wikipedia interface, immediate exploitation of semantic annotations, possibility of hiding functionalities in order to fit different expertise levels, and support for reasoning, i.e., deriving knowledge not initially explicit.

However, the Semantic Wiki approach has also been target of criticisms such as the one in [6]. In that paper, the author suggests that the terms *Wiki* and *Semantics* are paradoxical to each other, such that their fusion would need significant additional effort before it can be achieved. While the term *Wiki* comes from Hawaiian language meaning "quick", the author reminds that semantics has been "endlessly studied for millenniums in literature, philosophy, philology, linguistics", [...]. Within its computational modeling by means of

² http://ontoworld.org/wiki/Halo_Extension

Ontologies, semantics is often captured along, at first, a time-consuming and non-trivial process of domain analysis.

In the educational context, one can observe a growing interest in the Wiki approach. Considering the students' perspective, the work reported in [7] involved a fourth-grade elementary class in programming learning, by providing a place for information exchanging and peer correction during the accomplishment of assigned projects. In [8], Lund and Smordal report two experiments conducted with Upper Secondary School learners studying English as a foreign language. One main goal was to investigate possibilities of how teachers could intervene to help students in the use of Wikis when compared to teacher's role in traditional Learning Management Systems.

With respect to the Semantic Wikis approach, in [4], the authors argue for its benefits for the learning process in addition to those already expected from traditional Wikis. One of such benefits would come from the creation of semantic annotations, which is supposed to promote reflection on contents and knowledge, since deep understanding of domain knowledge is required in order to achieve a formal model. Such models can be shared between the peers who might, indeed, get involved in a process of collective construction. Moreover, the teacher can follow and assess the students' progress, not only through the resulting structure, but also from the history of changes. Yet, the inferences that the system is able to perform, thanks to the semantic annotations, are likely to bring additional awareness to the student, eventually feeding a virtuous cycle, as knowledge gets progressively explicit.

3. A case study within theoretical computer science

By inspecting the literature, we identify a lack of initiatives involving computer-supported collective activities within the study of theoretical computer science. On the widespread domain of CS, we find however relevant work within the CSCL community, e.g. COLER [9], Synergo [10], and Collect-UML [11]. From the student perspective, these tools provide the synchronous construction of artifacts like ER diagrams, concept maps, and UML diagrams, by small groups. In this section, we present one possibility of exploiting Semantic Wikis, which pages can embed FLA related diagrams (e.g. those edited within JFLAP), in addition to usual text. The students are supposed to contribute while following a face to face course, both synchronously in classroom and asynchronously between the classes. For the course being reported, Semantic MediaWiki [5] was used. The reasons for this choice include the popularity of the Wikipedia project, and hence MediaWiki, and also the great number of extensions available allowing to increase its functionalities.

3.1 Setting up

The proposed construction of tcWiki (standing for Theory of Computation Wiki) took place in the first semester of 2008 with a class of 36 students initially registered. In the first class, each student should be invited to create an account within the wiki, then to edit his/her user page and to introduce himself/herself to the class by using this page. Students' pages should then be used to compose small groups, each group having also a specific page. During the 4-months course, each small group should be assigned to the task of creating one or more topic articles, in-between the classes, corresponding to the content topics being studied. Navigation should be provided through the pages student – group – topic under responsibility, in both senses, as well as searching.

Each topic article should exhibit the group's understanding on the content. Concept maps and corresponding extracted sentences were recommended by the teacher to compose at first each topics article. The intent was to invite students to draw on their understandings and to inhibit them from pasting entire definitions from textbooks. Cmap Tools was recommended as an editor, but also an extension was provided for drawing graphs on wiki pages, using a script language. The construction should be monitored not only by peers, but also by the teacher and by two students having already passed the course (called monitors).

The corresponding discussion page for each topic article should be utilized with a double purpose. The first should account for traditional discussion on the article's contents by the wiki users. Requests or direct editing might then arise asking, for instance, to include references to an article, or to improve it. The second purpose should be the exercises to be proposed by the Teacher. Then, in classes preceding each exam, a pool should be organized aiming to pick up one solution to become one example in the corresponding topic article.

Table 1. Different possibilities for (linearly) presenting FLA topics.

Topics according to language level	Topics according to formalism nature
1.Regular Languages	1.State Machines
1.1Regular Grammars	1.1Finite Automata
1.2Finite automata	1.2Pushdown Automata
2.Context-Free Languages	2.Grammars
2.1Context-Free Grammars	2.1Regular Grammars
2.2Pushdown Automata	2.2Context-Free Grammars

The progressive creation of categories and semantic annotations was supposed to help students to increase their understanding about the links between the content topics. This links are far from being linear, though topics are often linearly presented to the students in textbooks or traditional course plans. Actually, the

topics can be presented in different sequences according to different textbooks or Teacher's chosen methodology (e.g. presenting all the formalisms accounting for a language level or presenting all formalisms sharing the same nature, as illustrated in Table 1).

In addition to the categories, students could create both attributes and relations between pages.

3.2 Running up

The main page (Figure 1a) was organized by the Teacher such as to present the overall purpose of the wiki within the course, people involved, and the main links. For instance, links to the topic pages were progressively organized, as the pages were created by the groups. In order to show this organization, we used the CategoryTree extension. Also, the Teacher provided a link to the Users page, along with a link to the Groups page.

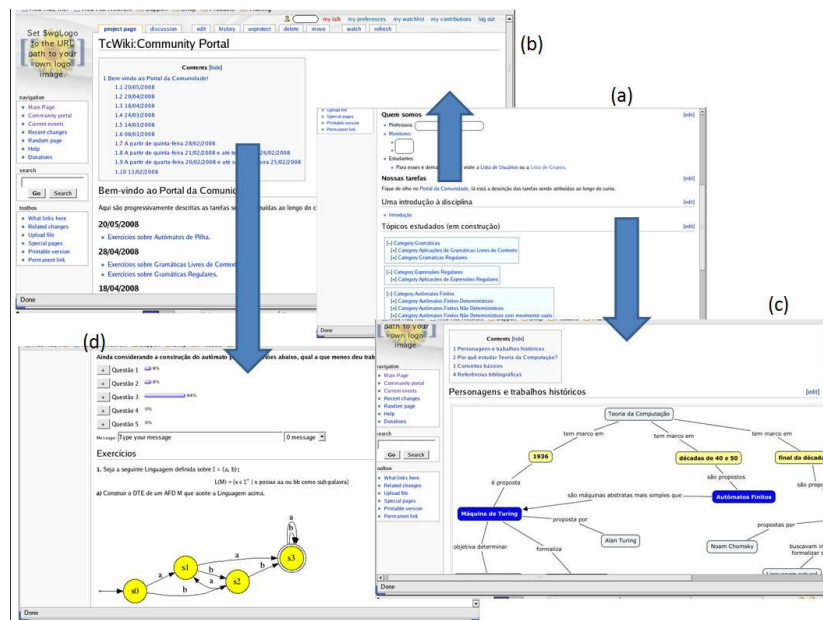


Figure 2. Main page and some pointed pages.

The Community Portal page (Figure 1b) was progressively updated with links to the Exercises (Figure 1d) that the Teacher proposed each week for each topic (as stated above, each Exercise list was included in the Discussion page of the corresponding topic article).

An Introduction page (Figure 1c) was prepared by the Teacher with an overview of the course topics. This page included some concept maps (summarizing the students' work) followed by corresponding text. This page served also as a model for the groups to build their assigned topic pages. Only one group followed the Teacher's suggestion and included a concept map on the owned topic page.

One example of the semantic annotations that could be included in pages is the relation *Responsible-for*, which assigned (the page of) a group to (the page of) a topic (Figure 2). The creation of this relation allowed the automatic creation of a relation page in which the user could visualize all assignments of groups to topics.

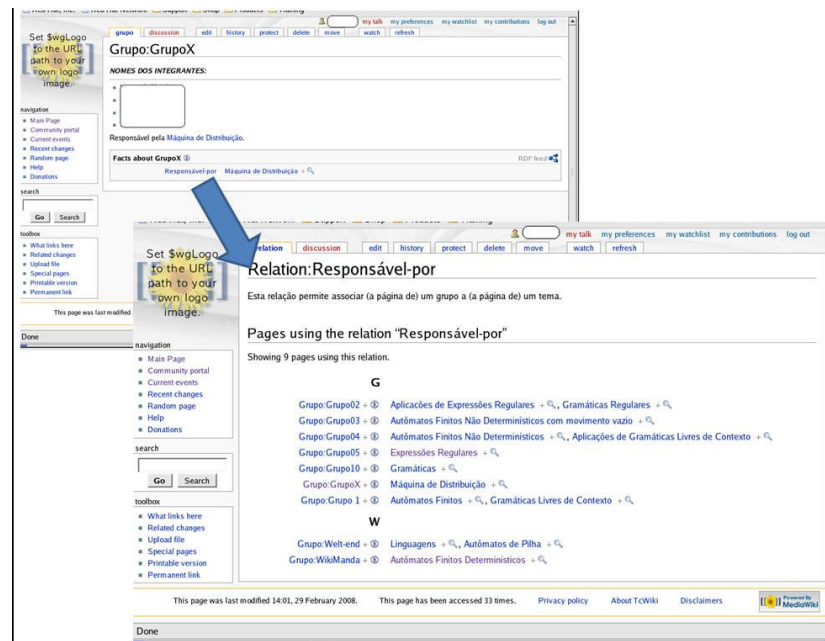


Figure 2. Group page with one semantic annotation (Relation) and the corresponding automatic generated page.

A positive point that we highlight from the Teacher's statement at the end of the course is mainly the increase of engagement of the students when compared to previous courses. This involved not only student's relationship with contents, but with each other in classroom and while doing their homework. On the other hand, one point that deserves attention, according to the Teacher is the resulting low amount of links between the pages, which, in the case of the domain being considered, was the main expectation in order to address the non-linearity of the domain. The linearity still remained, as one can observe in the topics organization represented by the category hierarchy (Figure 1a). This can be interpreted as a

sub-utilization of the expressivity power of the Semantic Wiki, as well as the high level of abstraction of the domain.

4. Conclusion

In this paper we present a suggestion on how to exploit a Semantic Wiki as an asynchronous and collective tool to support FLA courses, by embedding artifacts like JFLAP constructs, as well as a domain knowledge ontology having also the students as authors. A real use case was conducted leading to an increase of the degree of students' engagement with the course. Some detected points to be addressed include a better exploitation of links between content topics, which is expected to promote in students a better understanding of the domain. As this is part of our ongoing work, a formal experiment is foreseen in order to obtain more conclusive guidelines for concerned teachers.

Acknowledgements

The authors would like to thank *Fundação de Apoio à Pesquisa do Distrito Federal* (FAP-DF - Brasília, Brazil) for the financial support to take part in the conference.

References

1. S. H. Rodger, B. Bressler, T. Finley, and S. Reading. Turning automata theory into a hands-on course. In *Thirty-seventh SIGCSE Technical Symposium on Computer Science Education*, pages 379–383, Houston, Texas, 2006.
2. V. Devedzic, J. Debenham, and D. Popovic. Teaching formal languages by an intelligent tutoring system. *Educational Technology and Society*, 3(2), 2000.
3. B. Leuf and W. Cunningham. *The Wiki Way*. Addison-Wesley Professional, 2001.
4. S. Schaffert, D. Bischof, T. Bürger, A. Gruber, W. Hilzensauer, and S. Schaffert. Learning with semantic wikis. In *First Workshop SemWiki2006 - From Wiki to Semantics*, Budva, Montenegro, 11th - 14th June 2006.
5. M. Krötzsch, D. Vrandečić, and M. Völkel. Semantic media wiki. In *Proc. of ISWC*, 2006.
6. J. Rohmer. Wiki and semantics: Panacea, contradiction in terms, pressure for innovation? - some experiments and tracks towards intelligence amplifiers. In M. Völkel and S. Schaffert, editors, *Proceedings of the First Workshop on Semantic Wikis - From Wiki To Semantics*, June 2006.
7. S-H. Kim, H-S. Han, and S-G. Han. The study of effective programming learning using wiki community systems. In W. Nejdl and K. Tochtermann, editors, *First European Conference on Technology Enhanced Learning - ECTEL 2006*, pages 646–651, Berlin-Heidelberg, october 1-4 2006. Springer-Verlag. LNCS 4227.
8. A. Lund and O. Smordal. Is there a space for the teacher in a wiki? In *WikiSym'06*, Odense, Denmark, August 21-23 2006. ACM.

9. Constantino, A. and Suthers, D. (2000). A coached collaborative learning environment for entity-relationship modeling. In Gauthier, G., Frasson, C., and VanLehn, K., editors, 5th International Conference on Intelligent Tutoring Systems - ITS 2000, pages 325–333, Berlin. Springer-Verlag.
10. Avouris, N., Margaritis, M., and Komis, V. (2004). Modelling interaction during small group synchronous problem-solving activities: The synergo approach. In 2nd International Workshop on Designing Computational Models of Collaborative Learning Interaction, ITS2004, 7th Conference on Intelligent Tutoring Systems, pages 13–18.
11. Baghaei, N., Mitrovic, T., and Irwin, W. (2007). Supporting collaborative learning and problem solving in a constraint-based CSCL environment for UML class diagrams. *ijCSCL*, 2(2-3):159–190.