CollAnnotator - A Support Tool for Content Analysis According to Community of Inquiry Framework

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Abstract— Community of Inquiry (CoI) model is a framework with socio-constructivist roots, which describes an online learning community on three interdependent components: cognitive presence, social presence and teaching presence. Content analysis is widely used to examine transcripts of computer mediated conversations between students in a community of inquiry. However, there are no dedicated support tools for this process (apart from generic commercial software for qualitative data analysis). Therefore, in this paper we propose a content analysis tool specifically built for CoI, called CollAnnotator. The system provides several important features such as: comprehensive annotation functionality, support for multiple categories per unit of analysis, support for multiple coders and the negotiation process, detailed statistics and reports with graphical visualizations, all in an intuitive and easy-to-use interface. The paper describes the tool rationale, functionalities and some implementation details.

Keywords - Community of Inquiry, content analysis, annotation and classification tool, social media in education

I. INTRODUCTION

The *Community of Inquiry (CoI)* model, proposed in [3], provides a framework for describing elements which support the development of online learning communities [11]. The model has socio-constructivist roots and posits that participants in online learning environments need to recreate the social and knowledge building processes which take place in face-to-face classroom interactions [9].

According to CoI, learning develops through the interplay of students and instructors and can be characterized in terms of three components:

- Cognitive presence (the extent to which learners are able to construct meaning through sustained reflection and discourse);
- Social presence (the ability of learners to identify with the community and develop interpersonal relationships by projecting their personal characteristics into the community);
- Teaching presence (design, facilitation, and direction of cognitive and social processes to support learning)¹ [8].

These elements are interdependent and they all contribute

to the creation of a community of inquiry. The CoI model can be used to illustrate, analyze and express the outcomes of learning in online settings [9]. It was initially introduced for computer conferencing, but subsequently extended to other asynchronous communication spaces between students. More recently, it was applied also to social media settings [8], such as blog [1, 6], Twitter [10] or Facebook [5].

In this context, we also aim to use CoI for investigating the online community formed in our social media-based learning environment, eMUSE [7]. We have already performed a content analysis of student contributions in [8]. However, manual data collection and annotation proved tiresome and time-consuming and there was no support for dual coding (i.e., two individual researchers carrying out the classification). In addition, all reports and statistics had to be produced manually as well. A potential solution would be to use generic commercial software for content analysis (e.g., ATLAS.ti², NVivo³, Dedoose⁴ etc.). However, this is costly, more difficult to learn and use, not accommodating CoI specificities, it requires input data in a particular format and does not always offer support for multiple coders.

Therefore, we decided to develop an in-house content analysis tool dedicated for CoI, which can work in conjunction with our eMUSE platform. *CollAnnotator*, as it is called, is adapted to our requirements: it directly retrieves student content from eMUSE database and generates reports and statistics specific to our instructional scenario. However, the tool is very flexible and could be employed with different data sources and types of student contributions, regardless of the underlying platform. In addition, the tool offers support for content highlighting and annotation, for attaching multiple categories to one unit of analysis and for efficient comparison and negotiation between coders. Finally, CollAnnotator was developed with ease-of-use in mind, providing a rich and user-friendly interface.

To the best of our knowledge, no similar tool has been proposed in the literature for analyzing students' contributions according to CoI. The rest of the paper provides an overview of CollAnnotator tool, outlining its rationale, functionalities, some technical details as well as potential extensions.

¹ Community of Inquiry Model: <u>https://coi.athabascau.ca/coi-model</u>

² <u>http://atlasti.com</u>

³ <u>http://www.qsrinternational.com/nvivo-product</u>

⁴ http://www.dedoose.com

II. COLLANNOTATOR DESCRIPTION

The tool name points to the *collaborative* process which takes place both among the coders (who jointly *annotate* and categorize students' contributions) and among the students (who learn by communicating and collaborating in a community of inquiry). An overview of the functionalities offered by the tool is presented in the next subsection.

A. Functionalities

The main features provided by CollAnnotator include:

1) View, annotate and categorize student contributions

The tool was purposely built to work with our eMUSE social learning platform [7], so it currently provides the possibility to categorize two types of student contributions: blog posts and tweets (although others could be easily added). These are retrieved from eMUSE database and made available to the coder for easy annotation. The content of each blog post is shown in the original HTML format used by the student. In addition, the coder may view the title, date, type (post or comment), author name and team the student belongs to; the coder may also follow the embedded URL to visualize the original post on Blogger, if needed. Various search, filtering and sorting options are also available. Similar information is provided for the tweets (with the exception of title, which is replaced by URL). In what follows we will use the generic term *post* to designate both blog and microblog contributions.

The coder can classify each student post according to CoI framework, by selecting the *primary category* it belongs to. The coding scheme proposed in [9] is used, i.e.:

- Teaching presence (with categories: Design and organization; Facilitating discourse; Direct instruction; Assessment)
- Cognitive presence (with categories: Triggering event, Exploration, Integration, Resolution)
- Social presence (with categories: Affective, Open communication, Group cohesion).

In addition, the coder can add a comment in order to justify or explain her selection (e.g., specify the *indicator* used for the particular category; for example, indicators pertaining to *Affective category* include: *Expressing emotions; Use of humor; Self-disclosure; Use of unconventional expressions to express emotion; Expressing value* [9]). Furthermore, since some posts are rich enough to belong to multiple categories, the coder has the option of selecting also a *secondary category* (together with a corresponding comment).

The choice of a whole post as a *unit of analysis* for our tool is based on the considerations provided by several authors [1, 4, 10]. In addition, our tool offers coders the possibility to refer to a specific part of the post (i.e., word, sentence, paragraph). By simply selecting the desired section of the post, a highlight, an optional comment and a set of tags can be added. This additional content annotation functionality helps coders include further justifications for their category selection, as well as a more detailed personal interpretation of the post. A screenshot of the coder interface can be seen in Fig. 1.

2) Compare and negotiate assigned categories

Once a coder has finished classifying posts, he can view the classification provided by the other coder(s). The categories for which there is a disagreement are highlighted in red, so that the coder can get a quick overview of the posts which require negotiation. Furthermore, by visualizing the comments, highlights and tags provided by the other coders, he can get a better understanding of their perspective. The negotiation process can thus be performed more effectively and efficiently; by adding comments, the coders could even reach consensus without the need of a face-to-face meeting. Finally, the coder has the option to change their initial category selection, as they see fit.

3) Visualize reports and statistics

CollAnnotator also provides various reports and statistics regarding the classification results. Summarizing tables are included, which count the number of posts pertaining to each presence and category, according to each coder. A percentage agreement between the coders is also computed. Various options are taken into account (blog posts vs. tweets, primary category vs. both primary and secondary category). The researcher can thus get a quick overview on the level of agreement between the coders, as well as the categories which entailed most misunderstandings. Comparisons between the roles played by the blog vs. Twitter in the community of inquiry can also be made. In addition, suggestive charts are provided, which offer an intuitive overview of the distribution of presences and categories covered by students' posts.

Another important functionality offered by CollAnnotator is the support for more in-depth analyses, by providing reports at student and team level. All the tables and charts computed for the whole community are also generated for each individual learner and each team. Thus researchers could investigate the profiles of individual students/teams, the proportion of each presence they exhibit and their contribution for the construction and maintenance of the community of inquiry.

B. Architecture and Implementation

CollAnnotator is designed using a three-layer architecture, based on ASP.NET MVC 4 framework and C# technologies.

The presentation layer includes the view component of the application; pages are designed using HTML5 and CSS3 and the highly responsive design is achieved using Bootstrap open-source front-end framework. Several JavaScript libraries are used: Annotator ⁵ for implementing the annotation process and Highcharts ⁶ for designing the interactive, user-friendly charts.

The business layer includes the logic component of the application; Repository pattern is used to create an abstraction between the business and data access layers, while Unit of Work pattern provides a synchronization mechanism by assuring that all repositories use the same database context.

⁵ <u>http://annotatorjs.org</u>

⁶ <u>http://www.highcharts.com</u>



Figure 1. CollAnnotator interface - Annotate blog posts functionality

The data access layer communicates with a Microsoft SQL Server database using EntityFramework⁷, an object-relational mapping framework for ADO.NET. Learner data is retrieved from eMUSE platform, which stores all students' blog posts and tweets. However, a different data source could be easily used, with a slight modification of the data migration script; therefore, CollAnnotator is very flexible and could be employed for classifying other types of student contributions as well, regardless of the underlying platform.

III. CONCLUSION

The paper proposed a support tool for content annotation according to Community of Inquiry framework. CollAnnotator, as it is named, provides essential and distinctive features such as: support for multiple coders and the negotiation process, comprehensive annotation functionality, support for multiple categories per unit of analysis, detailed statistics and reports with graphical visualizations, all in an intuitive and easy-to-use interface.

The tool was successfully applied in practice for analyzing the blog posts of 75 students who used eMUSE in the context of a project-based learning scenario. The overall content analysis process ran smoothly and the two coders found CollAnnotator easy to use, effective and very efficient. However, detailed results could not be reported here due to space constraints. As future work, the tool could be enhanced by computing several inter-rater reliability measures, such as Cohen's Kappa or Holsti's Coefficient of Reliability [9]. Furthermore, alternative coding schemes could be integrated in CollAnnotator, as suggested in [2].

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⁷ <u>https://www.asp.net/entity-framework</u>