Beyond Traditional Metrics: Using Automated Log Coding to Understand 21st Century Learning Online

Denise Nacu
DePaul University
243 South Wabash Avenue
Chicago, IL 60604 USA
dnacu@cdm.depaul.edu

Michael Schutzenhofer
DePaul University
2219 North Kenmore Ave
Chicago, IL 60614 USA
mschutz1@depaul.edu

Caitlin K. Martin
Digital Youth Network
14 East Jackson
Chicago, IL 60604 USA
cmartin@digitalyouthnetwork.com

Nichole Pinkard
Associate Professor
DePaul University
243 South Wabash Avenue
Chicago, IL 60604 USA
npinkard@cdm.depaul.edu

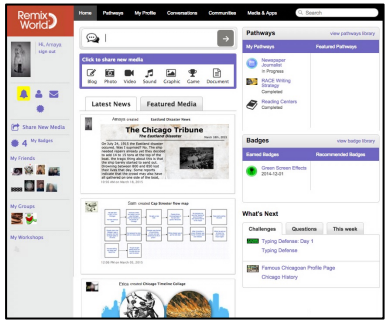

Figure 1. iRemix online social learning network for youth and adult educators.

L@S 2016, April 25-26, 2016, Edinburgh, Scotland Uk
ACM 978-1-4503-3726-7/16/04.
http://dx.doi.org/10.1145/2876034.2893413

Abstract

While log analysis in massively open online courses and other online learning environments has mainly focused on traditional measures, such as completion rates and views of course content, research is responding to calls for analytic frameworks that are more reflective of social learning models. We introduce a generalizable approach to automatically code log data that highlights educator support roles and student actions that are consistent with recent conceptualizations of 21st century learning, such as creative production, self-directed learning, and social learning. Here, we describe details of a log-coding framework that builds from prior mixed method studies of the use of iRemix, an online social learning network, by middle school youth and adult educators in blended learning contexts.

Author Keywords

Log analysis; educational data mining; online learning; teaching roles; 21st century learning

21st Century Learning Activities
Creative Production. Understanding and using appropriate media, elaborating and refining ideas and work, creating new and worthwhile ideas, developing media literacy and technological fluency and confidence through production and participation. *Related skills:* • **Developing Identity.** Ex., creating and editing user profiles. • **Creation and Sharing**. Ex., creating, editing, and posting creative work.
Self-directed Learning. Reflecting on learning experiences and processes, personalizing learning by making connections with individual interests and goals, taking initiative, being a lifelong learner, developing self-direction, making decisions, seeking out information. *Related skills:* • **Exploration.** Ex., looking at potential activities, using resources. • **Reflection.** Ex., Reviewing own work and progress.
Social Learning. Communicating and collaborating around work and ideas, being open to new ideas and perspectives, teaching and learning from others. *Related skills:* • **Communication.** Ex., Commenting on work, sending messages, and participating in debates. • **Observation and Connection.** Ex., Viewing and participating in groups.

Table 1. 21st century learning activities afforded in online social learning networks.

Introduction

Log analysis in massively open online courses (MOOCs) and other online learning environments has mostly focused on metrics that are aligned with traditional, lecture-based instructional models such as reporting findings related to course completion rates, viewing of course content, and grades received (e.g., [4], [9]). Several researchers have pointed out the inadequacy of these approaches and have called for conceptualization of new analytics that are more relevant to social learning models that emphasize personalization, collaboration on projects, and learning as a process of identity development as opposed to only accumulating content knowledge [3], [8]. Within informal learning contexts such as afterschool programs, less traditional outcomes have been documented that are critical to the 21st century skill-set, including managing information; directing learning pathways; collaborating on projects, discussion and critique around common artifacts; and building collective intelligence [1], [4].

Recent efforts to automatically code content from student and educator communication in online learning environments (e.g., discussion forums) have provided a promising start for improving feedback, promoting active participation, and fostering collaborative learning communities [5], [7], [10]. These efforts, such as gathering data on how often students revise their work [5], provide a richer perspective of student actions and learning processes than those obtained from traditional metrics. Despite these content exploration methodologies and growing interest in using networked online learning systems to foster 21st century skills, there is scant knowledge about how to find evidence of such learning using logs generated by users in systems such as MOOCs and other online learning networks.

We respond to this research gap by building a coding framework that can be used to inform system design, educator practice, and theory about online teaching and learning. This study aims to 1) develop a generalizable coding framework to support interpretation of student and educator logged actions that reflect 21st century learning, and 2) use these coding frameworks, metadata, and logged user actions to visualize and discover patterns to better understand learning and teaching online. Here, we describe our method of coding logs in the data-preprocessing phase. This type of coding framework is needed to reveal patterns of 21st century learning in systems such as MOOCs as well as smaller scale online learning environments.

Research Context

This work is part of a three-year study examining interactions among youth and adults in online social learning networks that lead to 21st century learning outcomes. Focusing on middle school youth, we have been engaged in design and research in both formal classrooms (English/Language Arts and History) and informal after school contexts (girl's electronics and wearable computing program) using iRemix (Figure 1), a closed social network that supports interaction among peers and adult educators around the creation, sharing, and communication of digital artifacts. In this context, users are on the system regularly (at least weekly) for extended periods of time (from six months to over two years), resulting in extensive logged activity by a stable user base of 141 youth and 16 adult educators. To generate our coding method and processing for this work, we looked at user activity over a 26-month period, totaling 203k actions. To help understand and validate our coding and interpretations of log data, we are triangulating with detailed qualitative data from the

Educator Learning Support Roles
Audience. View what youth are doing online
Encourager. Encourage youth about work or participation
Evaluator. Provide grades, ratings, badges, or other formal assessments
Friend. Exhibit personal approachability/ friendship/ mentorship including social posts, off-topic conversation
Instructor. Directly teach a concept or skill or provide an assignment. Provide prompts and/or feedback to further student thinking or work
Learning Broker. Connect youth with learning opportunities (e.g., people, activities, institutions, etc.)
Model. Share own creative work/process
Monitor. Impose or suggest rules of behavior online
Promoter. Showcase youth participant work
Resource Provider. Provide learning resources (how-to guides, links, embedded media, etc.)

Table 2. Educator online learning support roles.

learning environment, including classroom observations, and educator and student interviews.

Theoretical Framework

Our coding framework highlights both student and educator actions to describe learning interactions online. We build on previous work that has defined capacities and dispositions critical for learners in the 21st century [1], [4], prior studies of youth-educator interactions and roles played to support the development of such dispositions [1], [7], and analysis of common features of online social learning networks. Along with related skills supported in iRemix, Table 1 describes three strands of learning activities that are afforded in online social learning networks: *creative production*, *self-directed learning*, and *social learning*. For example, youth use the *message* and *debate forum* features to communicate with others. Although each activity has different implications in terms of the scope of the audience, both are evidence of social interaction online. Table 2 identifies key roles that educators play to support learners in developing these 21st century skills (see [7]). Like the student actions, the adult learning support roles are aligned with common social network features found in iRemix. For example, educators can play the *Audience* role by viewing individual youth artifacts and profile pages. They can play the *Encourager* role by submitting a status update that congratulates the entire group, commenting, or using reaction tags on an artifact.

Data Preparation and Coding Method

To prepare a target dataset for data mining and pattern analysis, we process a database of Actions from iRemix. Based on variables in the Action logs that indicate *who* performed *what type* of action *to whom* (if applicable), we derive *Actor*, *Action*, and *Recipient*. Together, data from these variables define a unique type of log to which we apply an interpretive code based on analysis of either *Student* actions or *Educator* actions. Thus, a set of coding rules use *Actor*, *Action*, and *Recipient* data to automatically generate the target dataset.

Coding Student Actions

For each student log (*Actor* = Student), the *Action* and *Recipient* data generates an interpretive code that makes student log data easily understandable to aid exploration by researchers and other stakeholders (see Table 3 for a sample of values for student logs). Table 4 shows a sample of how the interpretive codes link to the higher-level 21st century learning actions.

Action	Recipient	Code
View a video	Peer	ViewWorkOfOthers
View a video	Self	ReviewOwnWork
Create a video	N/A	Create
Comment on a video	Peer	Communicate
Edit a blog post	Self	EditOwnWork

Table 3. Sample coding of student logs (Actor = Student)

Coding Educator Actions

For each educator log (*Actor* = {teacher, mentor, …}), *Action* and *Recipient* data generates a learning support role code. Some actions cannot be coded automatically since the coding rules do not consider or interpret the related content (e.g., the text of a comment). In those cases, the code applied is *Hand*, indicating that it requires manual interpretation. Our prior research has used hand coding [7], and future work will explore the use of text mining to enable automated coding. A sample of coding educator logs is shown in Table 5.

Student Action Codes and 21st Century Skills
ViewResources → Work Independently (Self-Directed learning)
ReviewOwnWork →Reflection (Self-Directed learning)
Create → Creation and Sharing (Creative Production)
Communicate → Communication (Social Learning)
EditOwnWork → Creation and Sharing (Creative Production)

Table 4. Student action codes and their alignment to 21st century skills.

Action	Recipient	Code
Viewed a video	Student	Audience
Commented on a video	Student	Hand
Rated a video	Student	Evaluator

Table 5. Sample coding of educator logs (Actor = Educator)

Significance

The coding method presented here responds to the need for metrics that provide a richer picture of interactions in MOOCs and online social networks. By revealing types of actions that reflect models of 21st century learning, the coding framework helps to make these kinds of activities and interactions more visible to inform our understanding of online learning and the design of these environments. The ability to automatically code log data is a necessary first step to enable knowledge discovery using clustering and data mining techniques for a smaller scale system like iRemix, but also for larger scale learning systems and MOOCs. And, by coding actions with attention to user interactions (capturing actor, action, and recipient), we also lay the groundwork for robust analysis of social connections among participants. Future work will use coded log data for pattern analysis and data mining of iRemix data. We also aim to validate our framework by comparing log data to external assessments (e.g. [2], [5]), and explore application of this framework to log analysis of other online learning systems.

Acknowledgements

This work is based on work supported by the National Science Foundation (1325004).

References

1. Barron, B., Gomez, K., Pinkard, N., Martin, C.K. 2014. *Digital Youth Network: Cultivating Digital Media Citizenship in Urban Communities*. MIT Press, Cambridge, MA.
2. Care, E., Griffin, P., Scoular, C., Awwal, N., & Zoanetti, N. (2015). Collaborative problem solving tasks. In P. Griffin and E. Care (Eds.). *Assessment and teaching of 21st century skills: Methods and approach*. Educational Assessment in an Information Age. Dordrecht, Springer: 85-104.
3. Eisenberg, M., & Fischer, G. 2014. MOOCs: A perspective from the learning sciences. *Proc.ICLS 2014*.
4. Ho, A. D., Reich, J., Nesterko, S. O., Seaton, D. T., Mullaney, T., Waldo, J., & Chuang, I. 2014. HarvardX and MITx: The first year of open online courses (HarvardX and MITx Working Paper No. 1).
5. Koenig, J. A. (Ed.) 2011. *Assessing 21st century skills: Summary of a workshop*. National Academies Press, Washington, DC.
6. Kulkarni, C., Bernstein, M. S., & Klemmer, S. 2015. PeerStudio: Rapid Peer Feedback Emphasizes Revision and Improves Performance. In *Proc. ACM L@S 2015,* 75-84.
7. Nacu, D., Pinkard, N., Martin C., & Gray, T. 2014. *Analyzing educators' online interactions: a framework of online learning support roles.* Learning, Media and Technology, DOI: 10.1080/17439884.2015.975722
8. Pea, R. 2013. Learning Sciences and Learning Analytics: Time for a Marriage. *EDUCAUSE Learning Initiative, February* (Vol. 5).
9. Perna, L., Ruby, A., Boruch, R., Wang, N., Scull, J., Evans, C., & Ahmad, S. 2013. The life cycle of a million MOOC users. *MOOC Research Initiative Conf.*
10. Skrypnyk, O., Joksimović, S., Kovanović, V., Gašević, D., & Dawson, S. 2015. Roles of course facilitators, learners, and technology in the flow of information of a cMOOC. *Br. J. Educ. Technol. Spec. Issue MOOCs*.