A Digital Dashboard for Supporting Online Student Teamwork

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ABSTRACT

Teamwork skills are crucial to college students, both at university and afterwards. However, few tools exist to monitor student teamwork and to help students develop teamwork skills. We present a tool which collects the interactions of students who are using online platforms to complete a sustained task as a team; conducts a range of analyses of these data; and then presents information about team and team member behaviors in real time on a digital dashboard. This dashboard provides instructors with a user-friendly picture of team and team-member dynamics, which can also be made available, as appropriate, to both teams and team members. While some behaviors have been shown to be (or

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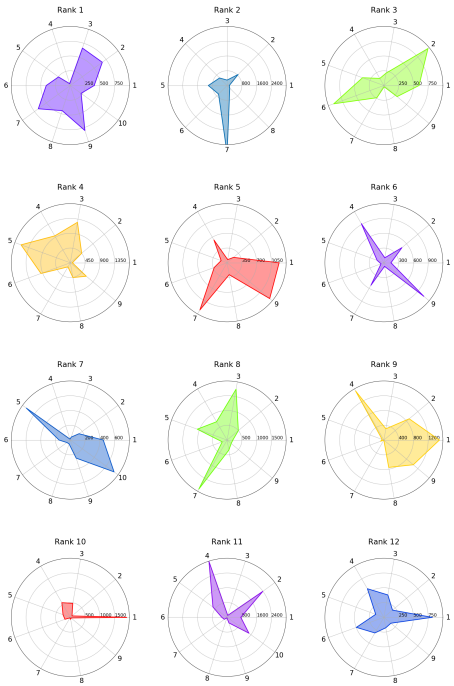

Figure 1: Number of words contributed by individual team members to each team's total word count. Team rank reflects where team's final project presentation was ranked, from first to twelfth.

are self-evidently) beneficial or harmful to team performance, these data and analyses also make possible exploration of whether less obvious behaviors affect team outcomes and performance.

INTRODUCTION

Teamwork skills are crucial for college students, both for their learning while at university [9] and for their employability and career success after graduation [1, 2]. However, relatively few tools are available to effectively assess the teamwork skills of students and provide a basis for improving them [4], and those that do exist suffer from a variety of shortcomings [8, 16]. In addition, almost all tools provide only episodic information: snapshots of team and team member performance at widely-spaced intervals, with the major and sometimes only evaluation often taking place at or even after a team's activity ends. A recent article argued that "no study has shown that technological support for group regulation can help teams to improve their course-based, collaborative discourse over time," [3] so there is clearly a need for work in this area.

This project describes the development of a dashboard that allows real-time monitoring and assessment of student teams working online, and enables instructors to provide regular and ongoing feedback to support teams and team members. This paper uses the data collected in a pilot study in Fall 2018 to demonstrate proof of concept and to do some initial analytical work, and the corresponding poster presentation will include a live demonstration of the dashboard, using data being collected at the time of the presentation.

METHODS AND ANALYSIS

With informed consent from participants, we collected the textual interactions of the members of twelve teams from a freshman Honors College class at a midsize American university. These team members collaborated on team projects during the Fall 2018 semester using an online platform (GroupMe). Using an API and a silent dummy group member, data collection was non-intrusive and required no extra action of students or instructors. Valuable information about team and team member performance was then gleaned from analyzing both the *form* [13] and the *content* [10, 12] of these interactions.

Formal analysis involves statistical and numerical examination of the characteristics and patterns of team member interactions, without reference to what the interaction-constituting messages are about. Amongst such characteristics are the frequency/number/length of team member contributions; total words exchanged per team or team member by time period; number of team members involved in a set number of interactions; and many others. Content analysis is currently performed automatically using off the shelf linguistic analysis tools, specifically Linguistic Inquiry and Word Count (LIWC). LIWC [15] categorizes words into roughly eighty different psychologically meaningful categories, signaling attentional focus, attitudes, perceptions, emotionality, social relationships, thinking styles,

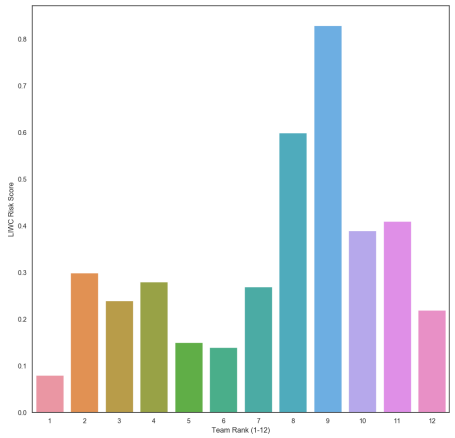

Figure 2: LIWC risk scores for each of twelve undergraduate freshman teams. Teams whose final projects were ranked higher (ranks along the x-axis) tended to have lower risk scores than teams which ranked lower.

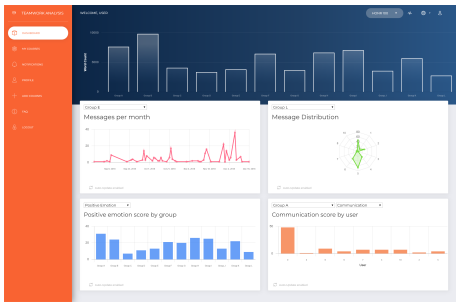

Figure 3: Dropdown menus on a Teamwork Analysis Dashboard, allowing instructors to explore LIWC features for either teams or individual team members.

authenticity, etc. Using LIWC, we can chart the distributions of words in different categories and how these distributions change over time. The insights resulting from such formal and content analysis, in conjunction with the insights from the well-developed literature on teamwork about the behaviors and practices characteristic of successful teams, provide a basis for assessing the level of performance of teams and team members. In addition, examining the interactions of teams that are successful by external measures (grades for team products or final projects, peer assessments, instructor observations, etc.) may reveal so far unrecognized behaviors that are typical of high-performing (or of under-performing) teams.

One example of formal analysis comes from Project Aristotle, Google's multi-year study of teams and team performance. Project Aristotle found that a team behavior that strongly predicted team success was that "members spoke in roughly the same proportion" [6]. Accordingly, it might be valuable to know how equally team members contributed to the conversation of their team. Figure 1 shows radar graphs representing the number of words contributed by each team member to the total number of words exchanged online by that team during discussion of the project. The teams' final projects were also assessed according to a rubric and ranked, though there do not appear to be any strong relationships between how equal the word contributions of team members were and those rankings.

Another central finding of Project Aristotle, corresponding to content analysis, was that successful teams were characterized by "interpersonal trust" and "mutual respect" and did not punish risk-taking. Put another way, members of high-performing teams felt a sense of "psychological safety." [6] This conclusion is reinforced by teamwork research in psychology[5], human resources [14] business [11] and organizational studies [7]. One of the LIWC categories is "risk"- the higher the risk score for a text, the greater the prevalence in that text of risk or threat language (for example, words like caution, beware, careful, doubt, distrust, wrong, fail, problem, inhibit, fault, difficult, crisis). LIWC generated a risk score for each team, and those risk scores are represented in Figure 2.

The dashboard draws on analyses like this to provide information in two forms. First, it includes a set of standard, easily-interpreted graphical indicators about teams in instructor classes, such as those in Figure 1 and Figure 2. These indicators present a real time picture of the state of affairs in each team. Second, it enables instructors to explore the aspects of team and team-member performance that interest them in more depth. Instructors can ask about teams or individual team members, select queries about either target, and retrieve information about these from the dashboard using drop down menus (Figure 3).

PRELIMINARY RESULTS

Our work so far has served mainly as proof of concept, with the goal of showing that data can be effectively and efficiently collected from students working in online teams, analyzed, and presented

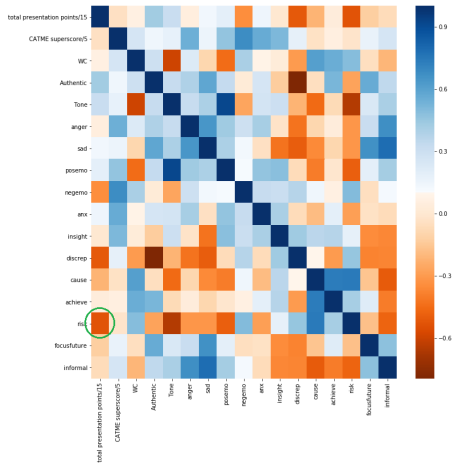

Figure 4: A correlation matrix relating LIWC features with one another and team scores. The colormap on the right of the matrix describes the range of correlation, from positive (blue) to negative (red). We can see a negative correlation between the presentation points and the risk value (circled in green.)

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intelligibly and in ways that enable instructors to understand and support teams in their classes. A secondary goal has been to identify interesting correlations, especially between between features of team-member interactions we have analyzed and any existing assessments of the performance of these teams. The data we collected in this initial phase came from a freshman Honors College class, which is intended as much to socialize students into university life as to provide a rigorous academic experience, and which is graded on a pass-fail basis. Accordingly, the commitment of students to their team processes and projects may have been lower than it would have been in other, graded classes. Nonetheless, we did find some interesting correlations between team behaviors and success according to the standards of the course (final team presentations were assessed and teams were ranked). For example, in Figure 2, teams are arranged left to right in order of their final presentation rankings. It is evident that most of the teams which were ranked higher had a lower LIWC risk score than most of the teams that were ranked lower. The same phenomenon is reflected in Figure 4, a matrix which correlates LIWC features with one another, as well as LIWC features and the scores used to determine rankings for team final projects. The circled cell in the bottom left of the diagram indicates that a higher team score was negatively correlated with LIWC's risk feature.

FUTURE WORK

Future work will take several directions. First, we will continue to refine the usability, accuracy and comprehensiveness of the dashboard and its underlying data. For instance, LIWC and similar tools can provide useful insights into team dynamics and behaviors, but such tools were not specifically designed for understanding teamwork. An important next step will be to develop linguistic analysis tools purpose-built for analyzing teamwork interactions, and especially sensitive to whatever we learn to be predictive of team success or failure. We have already begun to code a set of about 5,000 team member messages by hand, with labels which we believe are predictive in these ways, and will use this label set, and others which follow, to train a neural network to complete this coding automatically. Second, we plan to explore whether and how to present data about their team interactions and behaviors to student teams and team members themselves, and what forms of accompanying messaging and feedback- beyond simple mirroring- will most effectively help them reflect on, regulate and improve their collective processes. Insights from behavioral psychology are likely to be instructive in this regard. Third, though online and distributed teamwork is likely to become ever more common, face-to-face teamwork is still very much with us, and will remain with us for the foreseeable future. We therefore intend to expand our scope to the capture and analysis of face-to-face team interactions.

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