Showing *and* Telling: Response Dynamics in an Online Community of Makers

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Abstract: Online communities are an important learning resource, especially for learners in Makers, Making, and 3D printing. In this study, we examine one online Maker community called SoliForum to better understand how an emphasis on producing physical objects shapes online interaction; specifically, what kinds of messages elicit useful responses for those seeking help. We found that compared to text-only posts those with media elements had a higher response rate and more resolved problems. Based on our analysis we attribute this to the more descriptive and explanatory power of multimedia and its ability to better represent physical objects. The findings suggest that guidance for crafting messages using multimedia can lead to more equitable participation and learning in online Maker communities.

Introduction

Prior work on the educational implications of Maker Movement (Halverson & Sheridan, 2014) has focused primarily on informal learning in physical spaces or Makerspaces (Forest et al. 2015). A crucial element that is missing is the role of online communities in in supporting informal learning related to Making. The Maker Movement resides largely in the digital ecosystem and this self-emerging, cyber-physical, and sociotechnical system is one of the primary innovations of the Maker Movement (Litts et al. 2016; Martin, 2015; Rafalow, 2016). Writing about the potential impact of the Maker Movement on education, Martin (2015) outlined three critical elements to consider: 1) availability and advances in digital tools, including rapid prototyping tools and low-cost microcontroller platforms, that characterize many making projects, 2) community infrastructure, including online resources and in-person spaces and events, and 3) the maker mindset, values, beliefs, and dispositions that are commonplace within the community. He argues that integration of new tools into the practices of Makers is relatively easy because in the online community "people can read manuals and tutorials, watch videos, converse through forums, and share code (Martin, 2015, p. 34)." The value of the community also extends the role of mentors who provide the expertise required for problem solving and also serve as role models to youth. Martin (2015) recommends that given the role of community-driven processes in learning and identity development there should be more research on "online learning communities (p. 36)."

Online communities as a learning resource

With increase in online activity, online discussion forums have become increasingly popular for problem-solving and help-seeking (Teo & Johri, 2014). Research shows that online forums are also robust platforms for learning as they evolve over time and become a rich source of information for participants due to the interpersonal exchange. For instance, van De Sande (2011) examined an online help forum for mathematics and found that learners receive general forms of help that orient the learners towards resolving homework challenges. Similar findings are echoed by Puustinen, Bernicot, Volckaert-Legrier & Baker (2015) in their study of help-seeking exchanges in homework help forums. These forums are not only helpful, they are also highly efficient. For instance, Teo & Johri (2014) found that more than 88% of posed questions in a Java forum receive at least one answer and answers were typically of high quality. Although prior work shows that online discussion forums have emerged as a popular source for problem-solving help and potentially for learning, online forums related to Maker/Making have to rely significantly on non-text based interaction, such as images and videos. What effect does this have on interaction among users if any? Prior work has examined use of text across a range of online communities and has looked at different forms of text-based information (e.g. Velasquez, Fields, Olsen, et al., 2014), but has not looked at response dynamics in a mixed-media online community environment, which is the goal of this study.

Case study of SoliForum

SoliForum is a popular 3D-prining online community that supported Solidoodle, a 3D printer launched in September 2011. Solidoodle 3D printers use digital files supplied by the user to create physical plastic parts. Although the company went out of operation in 2016, SoliForum was and remains an active community with in-depth discussions related to 3D printing. For this study, we analyzed one forum related to Solidoodle within SoliForum "Help/Repair/Maintenance", which we are calling SoliForum-Help. This forum focuses specifically

on help-seeking and sharing of 3D objects making problems. The forum contains 19,850 posts by 1179 community users across 2265 threads spread over 4 years (08/10/2012-09/10/2016). Similar to other online communities, the majority of users had 10 or fewer posts on SoliForum-Help but the response rate for questions was 93.8%. Of the total users, 4 members had more than 500 posts each whereas 29 community members had between 100-500 posts. Discussion forums differ in their design features and in SoliForum posts are chronologically ordered within a thread. There is no affordance for responding to a specific message within the thread and any new response just goes at the bottom of the thread. There is also no rating or vote for the posts. However, it allows users to incorporate different informational representations to convey a message, such as images, links, videos and attachments.

Response comparison

The data selected for this analysis are threads that received at least one response and fall into one of the groups: *group1-plain*, which include threads using plain text-only in the original post of the thread, and *group2-multimedia*, which include threads containing images, videos, or attachments in the original post of the thread. Table 1 summarizes the number of threads for each group and the response time to get the first response, response rate, which is the percentage of the threads in this group that got at least one response and the average number of replies in each group.

Table 1: Response time, rate, and average number of replies (multimedia vs. plain) groups

	Response time	**Response Rate**	**Average (#replies)**
Plain Group (N=714)	44 min 12 sec	93.3%	8 (SD = 10)
Multimedia Group (N=622)	48 min 5 sec	95.8%	9 (SD= 11)
p-value (alpha = 0.1)	p= 0.4981	**p= 0.02144**	**p= 0.04203**

The result of t-test statistics shows that the average number of replies and the response rate is significantly higher (90% confidence level) in the multimedia group. Although response time is faster in plain group, the difference in the response time between the two groups is not statistically significant at (alpha=0.1). Breaking the multimedia down into images, videos, and attachments (att), we can see a finer grain of the responses in the different data representation use; videos and images garnering more than the average response (Figure 1).

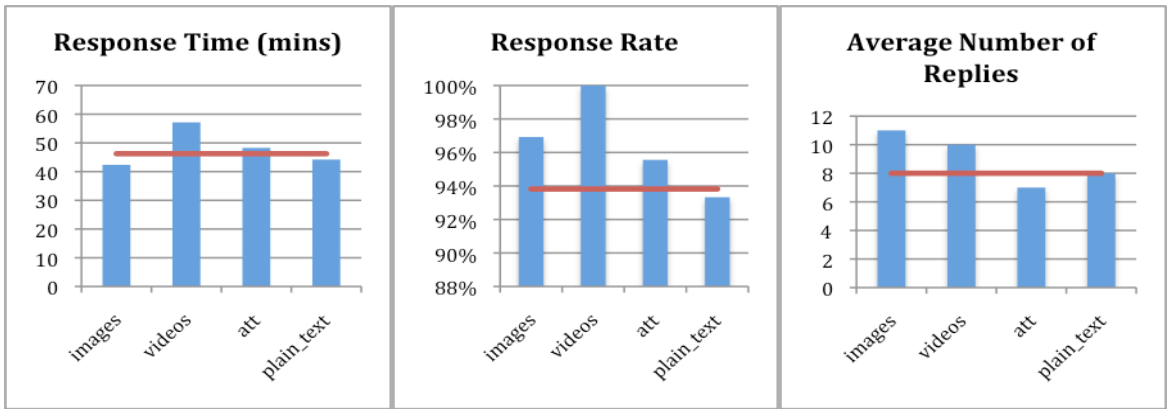


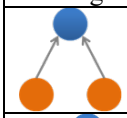
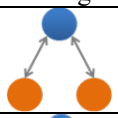
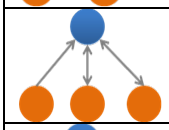
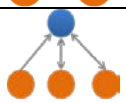
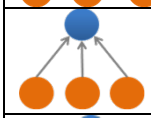
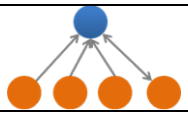
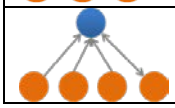
Figure 1. Response time, rate, and average replies in regard to multimedia element used (images, videos, and attachments) and plain text.

Identification of frequent communication patterns within a thread

To further understand the communication patterns within the forum, a network graph for each thread was constructed to analyze the communication among the participants (Teo, Johri & Mitra, 2013). Since SoliForum-Help does not have a "reply-to" feature to respond to a specific message within a thread, to determine the relationship between poster and responders the following assumptions have been made: (1) if it is a new poster and there are no quotes, it is a reply to the original poster; (2) if it is not the first post by the poster and post does not have quotes, it is a reply to the previous poster in the thread; and (3) if the post has a quote, the response is to the quoted member.

To identify the frequent sub-graphs in a thread a data mining algorithm *gSpan* was applied (Yan & Han, 2002). In this analysis, a sub-graph is considered frequent if it occurs in at least 25% of the discussion threads. To identify a frequent pattern across two groups, they should have the same length of conversation (number of replies) otherwise the algorithm will not detect patterns with higher degree (number of participants) because such a pattern will not exist in the shorter thread. After applying the algorithm and looking at the results for different conversation lengths, we decided to proceed with lengths 8 and 10 as a sample for our analysis because threads with fewer than eight messages did not show any meaningful frequent patterns and we did not have enough threads with more than 10 messages to have a representative sample of analysis. Table 2 presents the super frequent communication patterns among the participants in a discussion thread. All subsets of the super communication pattern are also frequent but not shown here for clarity. If a frequent communication pattern between participants occurs in one group but not the other, the latter is assigned (NF: Not Frequent), while the former is assigned the percentage of occurrence in the respective group. In Table 2 the blue circles represent the help-seeker who posted the original post in a thread while the orange, second level, circles represent help-givers. It can be observed in Table 2 that threads in the plain group have more unidirectional interaction. In contrast, multimedia group especially with length 8 tends to have more connected bidirectional relations within a thread. There were some interaction among help-givers but they were not frequent to happen more than 25% of the time.

Table 2: Frequent communication patterns (occurrence percentage) among participants within a thread

Sub-graph	**Plain Group**	**Multimedia Group**	**Sub-graph**	**Plain Group**	**Multimedia Group**
Messages/Thread (10)	N=18	N=26	Message/Thread (8)	N=32	N=32
	0.67	0.38		0.28	0.56
	0.33	0.31		NF	0.34
	0.56	NF		0.25	NF
	0.44	NF			

To supplement the findings of the sub-group analysis we further conducted a quantitative analysis of (1) help-seeking frequency and the number of help-givers participating in a thread for a sample that has 8 replies, and (2) text length for the two groups. Table 3 shows that the help-seeker (original poster) average participation within a thread in multimedia group is significantly higher than their counterpart group ($p=0.047<\text{alpha}=0.1$) possibly indicating that they are more engaged in the problem-solving.

Table 3: Comparison of help-seekers and help-givers across multimedia vs. plain groups (within a thread)

	Help-seeker participation		**Unique help-giver participation**	
	Mean	Standard Deviation	Mean	Standard Deviation
Plain Group	3.688	1.120	3.75	1.524
Multimedia Group	4.219	1.362	3.406	1.876
p-value	**p= 0.04652**		p= 0.21101	

Text length for both groups was analyzed in (Table 4) to see if using multimedia substitutes the text. An average word count shows a significant difference, hence median was also computed to account for any outliers and the difference is still significant. This suggests that forum users not only visually displayed the solution but also explained the steps textually.

Table 4: Length of text comparison for multimedia and plain groups

	Number of Threads	Word Count		
		Average	Median	SD
Plain Group	765	97.84	85	62.06
Multimedia Group	649	173.756	130	234.96

The presence of a back-and-forth exchange begs the question – is there ambiguity when the multimedia is used in the original post of a thread? To answer this question we did a qualitative analysis and read through a sample of 64 threads, 32 from each the plain and multimedia group, each with length 8 to examine the nature of interaction within the thread posts. There was no confusion observed when more complex informational representation (multimedia group) was used. In fact, about 21% of the plain group threads were asked or had provided a richer informational representation in the course of the discussion. The reason for this could be that multimedia group posters had specific questions and were eager to get the answer with more help-seeker engagement, while in the plain group, members asked primarily for suggestions (they had a breadth with higher number of respondents but less of help-seeker engagement). Furthermore, problems posed in multimedia group were more likely to be resolved (56.25%) as compared to the plain text group (where only 37.5% of problems were resolved). There was no definite marker of an issue being resolved and a thread was considered solved if the original poster acknowledged the issue is resolved. It is quite possible that the rate was higher.

Conclusion

The findings from our study illustrate that in this Maker-related community the use of photos, videos, and other media artifacts improved the response rate for those seeking help and the responses they received were more thorough and richer in information. Help-givers preferred the information they received from help-seekers to be in a form that was easy to understand. Help-seekers were also more engaged in the problem-solving process when they used more media. The primary limitations of this research are that the study is based on a single setting and the sample size used for comparison is relatively small.

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