Situated Cognition Genres; A Situated Learning Approach for Examining Informal Learning in an Online Community of Makers

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Abstract

This theory paper revisits the situated cognition paradigm through the lens of Makers and Making and argues that to better understand engineering learning in emerging digital sociomaterial contexts such as Maker communities it is critical to incorporate a genre perspective within situated cognition. The genre perspective provides a better analytical device to understand cognition, in particular, its discursive aspects. Unlike traditional situated learning settings where learners were embedded in the same site for extensive periods of time, current learning environments supports a lighter vein of cognitive apprenticeship as learners switch participation frequently and rely extensively on external sources. A *situated cognition genre* perspective also provides a mechanism to trace learners' trajectory across sites – both online and offline – and participate in different cognitive episodes. As an empirical case study, I examine an online forum related to 3D printing/Making called Soliforum. Consistent with research on situated learning, findings illustrate that digital materiality provides ample support for informal learning through affordances for displaying social characteristics, allowing use of different forms of informational resources, and providing support for problem solving activities among participants. The genre perspective facilitates additional examination of cognitive affordances of the online community by examining what constitutes the different cognitive episodes – asynchronous interaction; use of text, visuals, and videos; feedback from multiple experts; and the ability to learn from worked out examples. I argue that "*situated cognition genres"* is an important perspective for analysis of different engineering learning environments as well as for their design.

Keywords

Situated Engineering Learning; Genre Perspective; Informal Learning; Online Communities; Makers and Making.

Introduction

Increasingly, the Internet has become a major catalyst for learning across a range of domains and topics and learning environments can be imagined as open systems [12]. In addition to informational resources such as Wikipedia and YouTube, the Web also supports learning by providing a collaborative platform for people to ask questions and solve problems. From the perspective of engineering education, where learning is largely based on problem solving, the Internet now provides a viable platform for learners, especially those who do not have access to formal education or are engaged with engineering learning as a hobby. In recent studies researchers have found that through their lifetime people only spend about 14% of their time in formal learning environments and even when people are part of formal environments they undertake significant learning through informal activities [7]. The emergence and success of communities such as StackExchange that are directed towards question-answering also prove the viability of the Web in supporting users by providing support for problem-solving. These communities support a large number of learners who are engaged with developing a project or solving a problem and they make use of these online communities. As online user activity increases, online discussion forums, including social question and answer (Q&A) sites, are becoming increasingly popular for problem-solving and help-asking. Users of these sites ask questions, post responses, or search information from existing threads to satisfy their informational needs. One popular use of online discussion forums is to provide help with educational content [26]. Research shows that online forums are robust platforms for learning

as they evolve over time and become a rich source of information for participants due to the interpersonal exchange they. For instance, van De Sande [26] examined an online help forum for mathematics and found that learners receive general forms of help that orient the learners towards resolving homework challenges. Her research draws attention to the viability of online communities in facilitating learning mathematics outside the classroom and outlines opportunities to conduct deeper inquiries of online communities for informal learners seeking common interests and purposes. Similar findings are echoed in another study of help-seeking exchanges in homework help forums [19]. In recent years, Q&A sites in particular have gained immense popularity as sites for sharing of programming knowledge and for problem-solving (and studies suggest that Q&A sites are supportive environments. More than 88% of posed questions receive at least one answer and answers are typically of high quality [24]. Overall, although prior work has shown that online discussion forums have emerged as a popular source for problem-solving help and potentially for learning, these studies have just started to look at mechanisms, both technical features of the platform being used and norms of communication and sharing, which support this function [25]. What is especially missing from this work though is a focus on blended contexts such as Makerspaces to better understand emerging blended contexts for learning that are driven by authentic, user-defined, activities.

Makers and Making Online

In recent years, making and tinkering has emerged as a critical resource for informal learning related to engineering education [9, 21, 27]. Most prior work on the educational implications of Maker Movement though has focused on informal learning in physical spaces or Makerspaces [6]. As scholars and policy makers alike agree though, the advent of digital information technology has provided new affordances for supporting informal activities for learning by leveraging sociotechnical infrastructure to create productive learning environments that support active and distributed cognition [4]. One such sociotechnical infrastructure is online communities. This exploratory research takes as its starting point a crucial element that is missing from prior work on Making – the role of online communities in the Maker Movement and in supporting informal learning in Makerspaces. Although the physical material aspect of Making is what attracts participants – they can play with, work with, and produce concrete artifacts that they like and can personalize – the corresponding digital aspects of the process provides the affordance to share, problem solve, and innovate without the boundaries of a physical space. The Maker Movement resides in the digital ecosystem and it is this self-emerging, cyber-physical, sociomaterial system [13] which is one of the primary innovations of the Maker Movement [16, 20]. Without the digital elements, such as online forums and communities, the Maker Movement would not have achieved the scalability that it has in such a short period nor would it have had the diverse impact, in terms of education, outreach, or innovation.

Writing about the potential impact of Maker Movement on education, Martin [17] outlines 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. In particular, within the Maker realm, things are constantly evolving, such as availability of new microcontrollers such as Arduino, BeagleBone, and Raspberry Pi. What makes the integration of these tools into the practices of Makers easy is the "online community where people can read manuals and tutorials, watch videos, converse through forums, and share code [17, pg. 34]." Martin [17], further argues

that these communities add immense value as, “Without websites, magazines, and events that showcase projects, inspiration and ideation would be diminished. Without access to websites that host samples of code, digital design files, support forums, and how-to videos, it would be much more difficult to build project components and to troubleshoot the inevitable problems that arise (pg. 34).” Furthermore, the value of the community is not restricted to resources but also includes the role of mentors who provide the expertise required for problem solving and also serve as role models to youth.

There are increasing numbers of online communities being formed around maker practices that complement the in-person environment and create blended spaces. These communities and projects (such as http://fabathome.org) are often referred to as Do-It-Yourself or DIY projects and common example of these virtual organizations include online communities formed around microelectronics kits such as Arduino™ and rapid prototyping tools such as the printer developed by MakerBot™. Even before being able to organize online, such communities commonly existed and shared knowledge through physical meetings of ‘clubs;’ the most common example being communities formed around interests in automobiles and Makerspaces are a new incarnation of them.

Buehler et al. [15] is one of the first studies to undertake a large scale analysis of an online community related to 3D printing that reports who participates in these communities. They look at Thingiverse, a community associated with MakerBot™. They present results from a survey of all assistive technology that has been posted to Thingiverse since 2008 and distributed a questionnaire to the designers exploring their relationship with assistive technology and their motivation for creating these designs. They found that majority of these designs are intended to be manufactured on a 3D printer and include assistive devices and modifications for individuals with disabilities, older adults, and for medication management, and many of these designs are created by the end-users themselves or on behalf of friends and loved ones. From the perspective of this proposed research, the interesting findings are that more than half of respondents reported that they had no formal training in 3D modelling and personal fabrication tools and respondents described themselves as self-taught, learning techniques such as 3D modelling by watching videos on youtube.com and experimenting with open-source design tools. In their sample, the average designer has a technical background and majority of respondents were members of the STEM and health care community, with fewer than 36% reporting occupations outside of hard science or technology fields. While many of these designers claimed no previous experience with modelling tools, their formal skills in STEM probably supplemented their informal use of 3D modelling, 3D printing, and personal fabrication. The picture that emerges from this study is of community-centred innovative activities supported by an online sociotechnical infrastructure. This community, Martin [17] argues, can be conceptualized as a knowledge building community, a community, akin to a scientific community, that works collectively to build and share new knowledge. As other studies have also pointed out, the community provides a forum to share finished projects and can be a powerful force for the development of interest, identity, and content area knowledge; online communities due to their reach provide a larger audience and members with more and better expertise. Martin [17] recommends that given the role of community-driven processes in learning and identity development there should be more research on “online learning communities (pg. 36).”

Situated Learning in Online Communities: 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 (Figure 1). Interestingly, SoliDoodle is no longer in market but the community is still vibrant.

Figure 1: Screenshot of the Forum

Using one question posted in the "Help/Repair/Maintenance" area of the community, I first examine how different elements to situativity come together in the forum. This thread was started on April 30, 2016 and the subject was "(SD4) Need some help with Slic3r settings and messy prints." The total number of messages posted in the thread was 43 and the last message was poster on May 10, 2016. Figure 2 below shows a screenshot of the discussion forum.

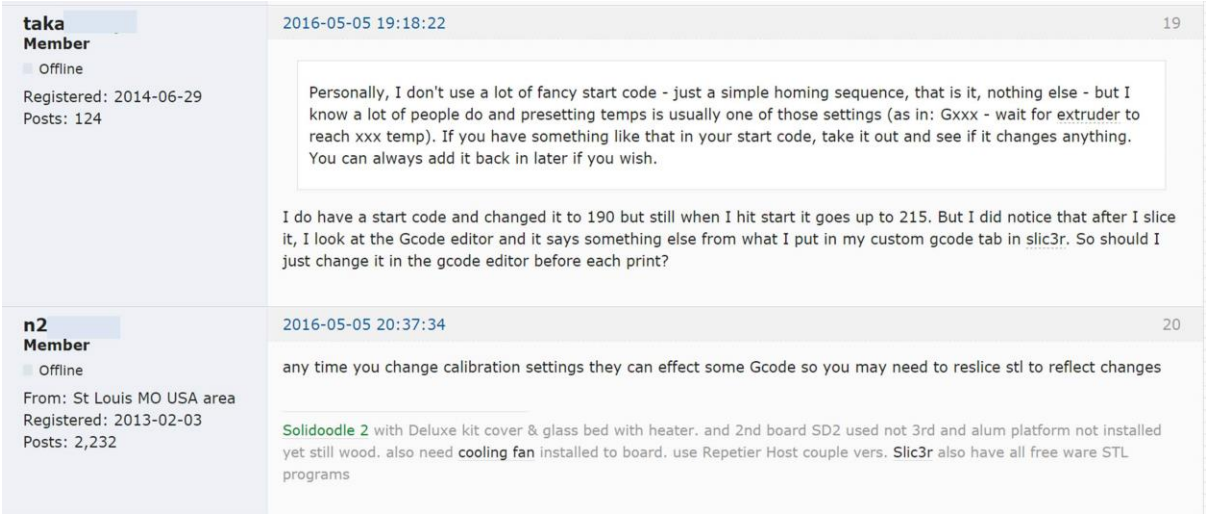


Figure 2: Screenshot of Discussion

In order to leverage both the situated perspective from the learning sciences and current findings from engineering education, we leverage a framework first articulated in Johri & Olds [14] and expanded and revised in [10] and [11]. This framework (see Table 1 presented later) synthesizes three key analytical features of the situated theory paradigm to help frame investigations of engineering learning: (1) the social and material context of learning, (2) the role of activities and interactions, and (3) the ideas of participation and identity in relation to situativity. Through this framework informal learning can be understood as a situated activity that takes place in a specific setting, a setting different than a formal classroom, and often involves students becoming a part of a community of practice over time. The situated perspective also helps shed light on the different identities that students take on as they work on different projects, for instance, as part of collaborative teams.

Participation, Identity and Other Social Elements of the Forum

The online community, as with other similar platforms, offers users the opportunity to display personal information and create a sense of community. For instance, each user has a unique username, information about when they registered, they can also state where they are from, and each message they post lists the number of contributions they have made to the forum. In addition, users with different roles such as a moderator have that information listed below their username. Another unique way to convey identity is for users to list the device they use as a signature under their posting. A unique username and information about participation on the forum allows members to better understand where a poster is coming from, what experience they have, and what kind of assistance they might need. It also lends to creating a greater sense of community. Although the forums are public and anyone can read the messages, only users who have registered can post original messages or reply to the messages. This serves two purposes, it disallows trolling and forces users to see themselves as engaged with a community rather than just a forum.

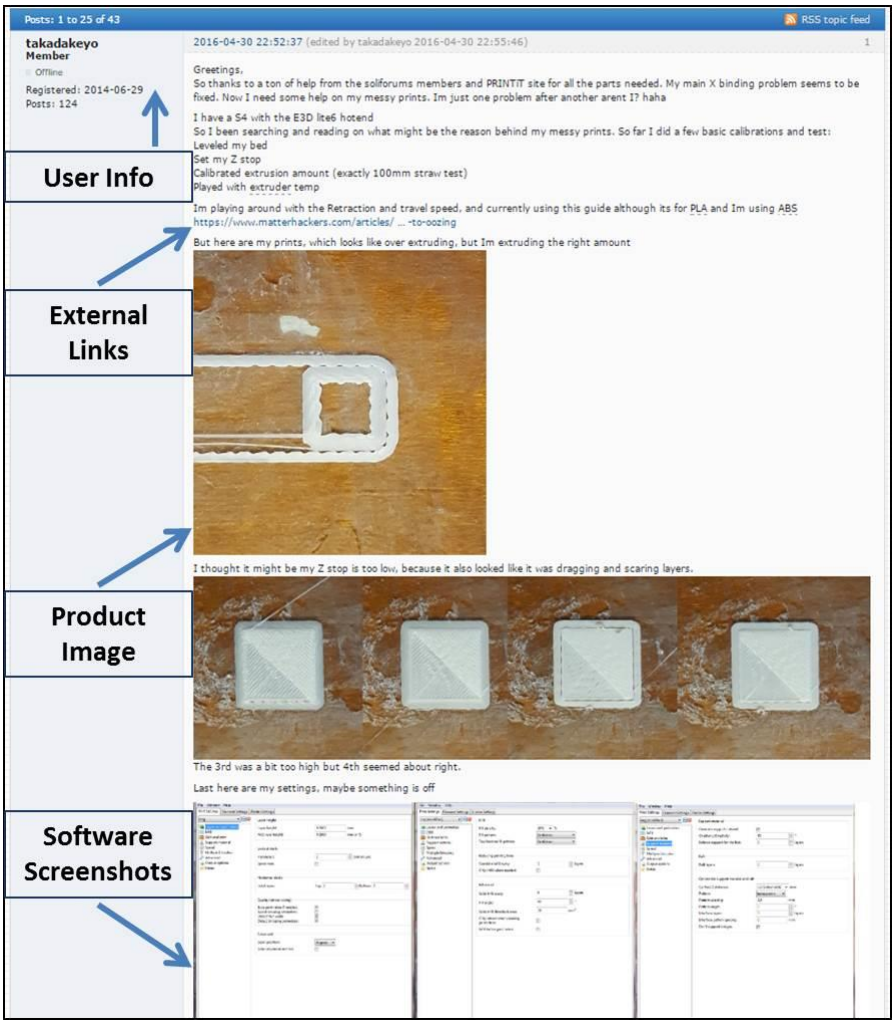


Figure 3: Elements of Problem Listed in a Post

Information Representations on the Forum

The other affordance of the forum is the different ways in which it allows the exchange of information among users. Although, as with most discussion forums, the primary source of information exchange is text based forum, on SoliDoodle the exchange of images is a critical component of discussions. There are different kinds of images shared. First, there are images of the product, what has been printed, and this is especially the case if the printing is defective in some ways. Second, another important kind of information shared via images is that of the software settings. To use 3D printers, many related software such as Slic3r have to be used to actually turn the instructions into an algorithm and screenshots of settings of these were common. Finally, often images of the printer itself would be shared especially if there was a breakdown or damage. The other information representations that were commonly used were external links. These were links to other webpages with relevant information or to videos. The forum does not allow the direct posting of videos, often a resource issue, and therefore users would post links to videos online or to one they had created. The user of videos was important as it could show the 3D printing in action.

Problem Solving as the Central Activity on the Forum

Although many users browsed the forums to read the information, as is evident from the views data for each thread, the primary activity of the forum was to assist with problem

solving for those who were having difficulties. Therefore, the original poster or OP started by clarifying the problem they were having, such as getting prints that are not clean, and potential solutions they have tried to resolve the issue. The problem definition often took the shape of text plus images, plus some external links if the poster had already tried solutions listed on other websites. Figure 3 below shows different elements of the first message posted by a user who is seeking solution to some issue they are having with Slic3r.

Table 1: Elements of Situativity Applied to Informal Learning in a Maker Community

	Relation to Engineering	***Implications for Research on Engineering Learning***	***Informal Learning in Online Communities***
Activities and Interactions	Engineering work is usually project based, accomplished by teams, and is highly collaborative	Empirical studies of team work and collaboration Empirical studies of role of interaction in engineering practice (peer learning, informal learning)	Participants share designs and solicit feedback; problem solving is collaborative even if it is not team or group based
Mediation in Social and Material Context	Engineering is highly dependent on mediating artifacts, including representations and uses significant kinds and amounts of physical materials as well	Empirical studies of role of representations Empirical studies of mediation by tools used in learning and practice Empirical studies of differences between the use of representations and materials in engineering design and engineering science and their relationship	Digital images, text, videos, external links, are all different representations that mediate interaction among community participants; physical objects are rendered digitally for social interaction and problem solving; discussion of scientific basis of observed phenomenon
Participation and Identity	Engineers have a strong community of practice – which often varies across disciplines – especially when they practice Engineering identity is distinct entity	Engineering community formation Engineering identity formation and differences in school versus work identity Situated identities and conflict between identities Open organizing and other emergent forms of practices based on technology use	Participants are from different backgrounds with related interest but it is unclear whether they identify with being an engineer in a normative way; the community shows the importance of open organizing for the Maker movement and support of digital platforms for making them popular and usable

This brief overview of a discussion post in SoliForum illustrates the situative aspects of engineering learning in an informal community. Table 1 illustrates how the empirical findings form the study relate to the situative framework [11].. As we can see, across all three major categories of the framework we find that an online community such as SoliForum support informal learning. In addition to providing support for problem solving through leveraging expertise of a diverse range of users, it allows participants to leverage the digital materiality of the forum to express and convey their problem in a complex manner. Although face-to-face interaction probably can lead to a faster solution, by providing guided assistance overtime the forum allows for better learning by the user. There are some drawbacks of an

online community in terms of better understanding who is participating and why, demographic information is not easy to come by, this is mitigated by creating a more egalitarian platform by participation that doesn't discriminate based on users' physical characteristics and allows them to form a reputation based on their contributions.

Genre Perspective and Situated Learning

The analysis above foregrounds the role that situated learning perspective can play in helping us better understand how digital materiality of online environments supports engineering learning. The theory also provides guidance on the specific affordances of digital materiality that are leveraged – such as multiple media, different ways of interacting and communicating, and formation of a community. Yet, from a deeper analytical perspective of understanding the specific ways in which learning takes places, identifying slices that demonstrate learning or knowledge sharing, the perspective lacks a coherent tool. For instance, where in this online environment does learning take place and what does it look like? If I want to take replicate learning and knowledge sharing, what can I do? These are some issues that, I argue, are better answered by incorporating a genre perspective within our understanding of situated cognition.

The roots of the genre perspective can be traced on the one hand to the works of Bakhtin [2] and the study of rhetoric, and on the other hand to empirical studies by social psychologists, in particular Goffman [8]. Whereas Bakhtin argued that foundational to human discourse and hence learning is dialogue [15], Goffman, by examining everyday human interactions, demonstrated that people follow certain scripts. These scripts or schemas allow one to function in the world without approaching everything as new. We are also able to translate them and even modify them for the same situation or for other situations. Like the notion of script [3], schema, or a plan, genre is a concept used to describe what people do in practice, specifically, their discourse or discursive practices. Genres are socially shared; Orlikowski and Yates [18] define them as "socially recognized types of communicative actions — such as memos, meetings, expense forms, training seminars—that are habitually enacted by members of a community to realize particular social purposes (pg. 542)." Often, these communicative actions can involve sequences of interrelated genres (e.g., a meeting may involve presentation and discussion genres; a class might involve group activity followed by an individual assessment) referred to as a genre system.

Overall, the genre perspective argues that there some typified ways in which humans communicate, particularly in their use of written text, but increasingly extending beyond that to other modes of communication such as email, blogs, weblogs, and even Twitter. Furthermore, genres are recurrently enacted structures that serve as institutionalized templates for social interaction and participants involved in enacting genres such as team meetings or academic reviews have expectations about the roles they and others play in the process, the reasons for engaging in the activity, the forms of the texts to be produced, the timing and location of the communications, as well as the actual sequence of discursive moves involved [29].

Within the literature on genre, there are many viewpoints related to the genre assemblages that form within any setting including genre sets, genre systems, genre repertoires, and genre ecologies [22, 23, 30]. From the perspective of situated cognition, the genre ecologies perspective is the most pertinent given its focus on mediation and the diverse range of activities in which learners engage in both online and offline environments. For the purposes of this paper, I am overlooking this aspect of genre practices given the focus on this work on establishing the viability of situated cognition genre perspective.

Cognitive Episodes as Building Block of a Situated Cognition Genre

The concept of genre offers a number of analytic advantages to understand cognition in context as cognition, inherently, is a social and discursive practice and understanding it requires paying close attention at the micro-level. The concept of genre, in turn, highlights the recurrent and situated nature of discursive practices, and provides robust methodological tools for studying the production, reproduction, and change of discourse. For example, in studying the electronic discourse of a group of computer scientists, Orlikowski and Yates [18] identified the repertoire of genres enacted by the participants over time and showed how these discursive actions reflected their collective purposes as well as the shared norms and relations of their occupational community. Similarly, learning in any given setting that relies on repeated discursive acts, which can be characterized as *cognitive episodes*, can be seen as a product of a situated cognition genre. Within SoliForum, the following elements are evident. The interaction among participants – learners and experts – is text-based but there is also use of visual and videos. The interaction among participants is asynchronous. Even though the response rate is not slow, unlike synchronous or near synchronous communication it lacks immediacy. The affordance it provides though is for deliberation and incorporation of different perspectives within the interaction as participants have time to think and reflect. Since Making is a physical activity and requires manipulating settings and reprinting, the ability to try things out is important. Furthermore, the platform allows multiple experts to weigh in on a problem thereby providing improved cognitive apprenticeship to learners.

To better understand the interaction and kinds of cognitive episodes present on SoliForum we conducted an empirical analysis of SoliForum threads that received at least one response (reported in detail in [1]. Threads with at least on response in SoliForum fell into one of the following 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. These two types of threads can be considered different kinds of cognitive episodes given the different use of discursive elements within the thread.

Table 2: 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**

Table 2 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. We compared the two groups and 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 4).

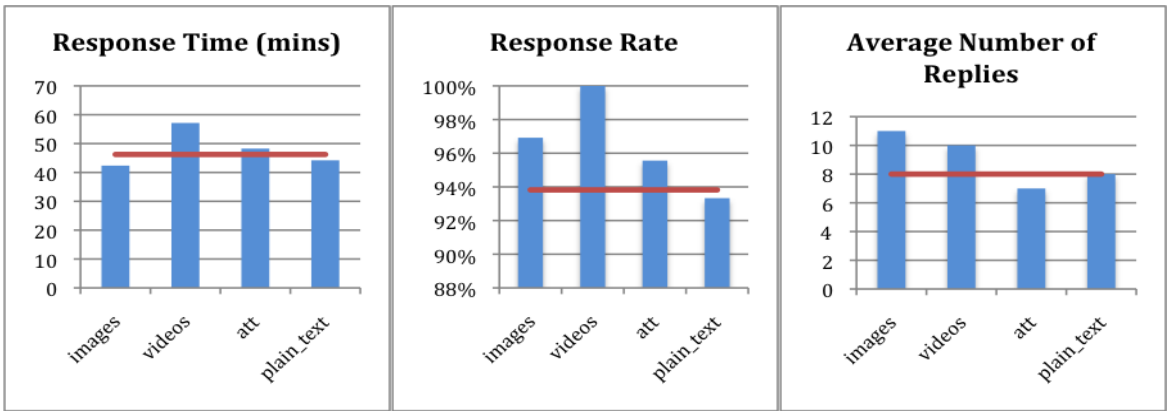


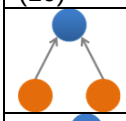
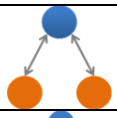
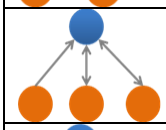
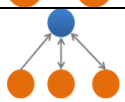
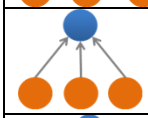
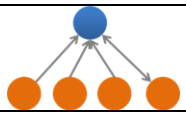
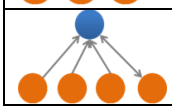
Figure 4: Response time, rate, and average replies in regard to multimedia element used (images, videos, and attachments) and plain text

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 [28]. 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.

This finding related to the number of messages shows that in addition to different kinds of cognitive episodes, their sequence within any thread was another crucial determining factor behind learning. Table 3 presents the super frequent communication patterns – akin to cognitive episode – 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 3 the blue circles represent the help-seeker who posted the original post in a thread while the orange, second level, circles represent help-givers. 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 3: Occurrence of frequent communication patterns (cognitive episodes) 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 4 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 4: Comparison of help-seekers & 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 analysed in to see if using multimedia substitutes the text (Table 5). 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 5: 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 counter exchange within the thread 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. 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.

This short analysis of SoliForum sheds some light on the issue of situated cognition genre and of cognitive episodes, the building blocks of a genre. We can see that within the community, specific routinized differences had forms across threads related to the use of texts and of multimedia – two different kinds of cognitive episodes – and the multimedia group illustrated higher knowledge sharing and learning. Not surprisingly, the use visual elements that showed rather than narrated a problem led to better problem solving. We do not have direct evidence of learning, but the nature of problem solving demonstrates the nature of cognition.

Implications and Future Work

The cognitive episodes observed in SoliForum are similar across a range of online discussion forums with some variations. The use of visuals and videos might differ depending on the topic of the forum. There are might be different kinds of moderation for who can post what and some forums, such as StackExchage forums, allow assignment of points – a quantitative measure – of the response received. Similar routinized episodes and hence situated cognition genres can also be identified across a range of face to face settings. The online settings are interesting from the perspective of data collection and analysis as the digital materiality of the setting presents an opportunity to examine data at a granular level. Although concrete evidence of learning is difficult to ascertain without some form of qualitative data collection, the digital data does provide the opportunity to use different techniques to better understand the nature of interaction.

The theoretical advancement presented here is preliminary and future work needs to be done to check the viability of the argument across settings. The granularity of what constituted a situated cognition genre and a cognitive episode also requires further empirical testing. One possible approach is to follow the trajectory of a learner across setting and identify cognitive episodes and instances of learning. The theoretical review presented here of the genre perspective is limited in nature and future work can better relate this work to existing work on genre.

Conclusion

This theory paper shows how online communities of engineering enthusiasts, especially those working on maker/making projects, are exemplar of informal learning from a situative perspective. In addition to illustrating the viability of online communities for situated learning, the *situated cognition genre* perspective has implications for the integration of online forums as part of engineering curriculum and also for motivating students by guiding them to participate in online forums. As online resources and platforms become more common, and engineering tools become more digitized, increasingly, engineering learning will look more like learning in online communities. This will also allow for easier collection of digital data and analysis of that to better understand how and what users are learning.

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