Engineering Students Rapidly Learning at Hackathon Events

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Introduction

Hackathon events are severely time constrained events technological invention sprints where programmers and engineers dive deeply into solving design challenges. Part of the experience is to learn as much as you can in a short amount of time, usually 24-36 hours consecutively. A majority of participants enter hackathons not knowing the direction of their intended project beforehand, and not knowing what specific additional information they will need to complete their project beyond their own technical abilities. These hackathons are not related to breaking into systems for the sake of exploitation, a popular but outmoded notion associated with "hacking."

This study explores how participants learn just enough to be able to "hack" together (design) a feasible solution. The concentrated and intense nature of hackathons magnifies the importance of applying learning strategies and specific types of knowledge to be able to contribute to the event. Participants often have to learn something new in a short amount of time, such as a specialized programming language and/or new hardware, and strategies to integrate both into a system. As projects develop over the duration of the hackathon, the needs of the project, and the skills needed for the project, can change quickly; participants need to be flexible and responsive to what they are learning. With limited time, the constraints of a hackathon event allows participants to find effective personalized learning methods to better understand, develop, and then very quickly apply skills crucial to their project's development and ultimate success.

In conducting this study, qualitative pre and post interviews have been conducted and analyzed using thematic analysis developed from Winne[1] for four participants with individual and team experiences. Guided by Grand et al's process mechanisms[2], observational data was collected and thematically analyzed. Further analysis combined the two sources of data to give a deeper understanding of self-regulated learning through context from an internal and external perspective[1]. In gathering prior knowledge of self-recognized methodologies from the participants themselves during interviews, supplemental observations collected throughout the duration of the hackathon provided visual evidence.

This work can be used to improve engineering education through a better understanding of possible personalized learning strategies through self-directed learning. By recording the processes these participants felt they took to learn, as well as documenting the actions of their methods of learning, we will determine if attributes of hackathons can help illuminate ways in which project based learning courses in engineering can be improved. We hope to continue and extend in future studies to further bridge a gap between personalized education and formal learning.

Rapid Learning By Doing

Hackathons are coding marathons that support the community. They are time constrained environments of typically 24-36 hours in which teams of about four or five people create and

develop a project of their choosing to demonstrate at the end of the event. Depending on the amount of participating teams or individuals, it can result in a divergent array of projects, where each can be a solution to a community problem, a personal problem, something creative, or all of the above. Regardless of the project or result, participants will have learned something new or refined their knowledge by the completion of the project.

In some ways, hackathons are similar to project based learning. Both provide students the opportunity to learn and refine skills in an applied practice. Much like project based learning courses hackathons encourage the formation of teams, however, this is done through prioritized acceptance, or a requirement for consideration for participation. Regardless, both provide experience in which individuals must learn to work on a team where they may or may not be familiar with the other members. To add to the complexity of the experience, the team might consist of people with different specialties, educational backgrounds, or desires for the project. Note that engineering project courses are significantly longer in duration in comparison; project courses meet at regular times per week over the course of a semester or academic session, and teams collaboration might be additionally outside of class with distributed communication by space and time.

Hackathons might provide additional valuable insight for personalized learning. With the open aspect of hackathons where students of all types have the opportunity to engage, the environment attracts students who desire to learn, practice and improve skills. The short nature of these events may require students to discover ways to make their learning efficient, and find solutions under the pressure of time, while still being motivated to complete their projects.

Literature Review

Hackathons

Hackathons are "best described as an invention marathon,"[3] according to Major League Hacking (MLH). The word's origin conveys a similar definition, having been "combined from the words *hack* and *marathon*… *hack* is used in the sense exploratory and investigate programming."[4] It is also known as a "coding competition,"[9] or an "event to innovate and develop prototypes, typically lasting at most a few days."[10] It is an environment that promotes innovation with a heavy time constraint that strains the participants' ability to achieve their innovative goals for the event.

Hackathons also have specific goals. University-hosted hackathons aim to "provide students with the opportunity to develop their skills."[3] Companies and organizations host them to "encourage digital innovation with their assets and resources."[4] Hackathons are often aimed at helping the local community even encouraging citizens to become involved. One university hackathon focused on "technology for the homeless [and to] expose students to the social impact of technology.[5]

While many hackathons center on technology, there are other types that do not focus on innovations solely through development. Focus might be developing ideas that could be used to solve a community or global problem. Briscoe and Mulligan[4] have developed categories for

hackathon types "loosely [grouping hackathons] as being either tech-centric or focus-centric." The focus-centric hackathons is socially-oriented, which "[aims] to address or contribute to an issue of social concern, such as public services or crisis management."[4] Some examples of tech-centric hackathons are application-type, focus ing on platform specific development, or technology-specific, which focus on creating applications using specific attributes such as a "language, framework, or Application Programming Interface (API)."[4]

MLH-sponsored hackathons are typically application-specific and technology-specific hackathons. These are accessible to a larger variety of participants. MLH hackathons are nearly always collegiate based hackathons and must follow guidelines provided by MLH. This contributes to a consistency in structure and purpose across the hackathons. MLH hackathons always have a venue, sponsors, a code of conduct, just-in-time tech talks, and in order to attend an application must be completed and accepted.[11] MLH hackathons accepts mostly collegiate students.

Hackathons are not associated with the negative connotation of "hacking." Hackathons do not have any "reference to committing a cybercrime"[4] nor breaching a form of security.

Self-Regulated Learning

There a gap in the literature on self-regulated learning in the context of hackathons. Zimmerman defines self-regulated learning as "students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process."[6] Self-regulated learning is also described as people "[seeking] out information when needed and [taking] the necessary steps to master it."[4] Effective self-regulated learning "is [dependent] upon… the possession and quality of basic learning-to-learn skills" and resources.[7] Students using self-regulated learning to expand their knowledge may have found their own preferred methodologies of learning. Not only are they achieving more knowledge than their peers by pursuing more knowledge, they are building their ability to learn.

Winne provides an approach to measuring self-regulated learning. Self-regulated learning is dependent on context, and it is also expected that context changes as learners redefine it upon approaching problems.[1] Self-regulated learning is composed of "metacognition, motivation, and strategic action." [1]

MLH hackathons promote small teams to coordinate with each other in order to develop and/or innovate a project by the end of the hackathon. In focusing on teams and how they learn with each other, a process theory helps to solidify a framework developed from Winne's approach. Applying "how knowledge emerges from the individual to the team-level" is important for the spread of information, and in seeing how one's actions of self-regulated learning can affect the team and vice versa.[2] This process theory provides the basis for understanding how learning occurs via self-regulated learning in teams. It also ties directly back to it in the sense that "attending to information in the environment" is a form of context being changed by the learner.[2] And "storing information" or "interpreting how newly acquired information fits with previous acquired information" becomes a way to identify the methods in which self-regulated learning appears. [2]

Project Based Learning

This pedagogical approach connects to project based learning in the engineering classroom. Project based learning "tries to develop students into active learners who actively acquire necessary knowledge to resolve problems that appear in the project."[13] An approach relevant to hackathons is a social approach focused on team-based learning and how it is a "social act where learning takes place through dialogue and communication."[12] Project based learning "focuses on organizing self-learning [and] through practical activities, interactive discussions, independent operation and/or team cooperation, students reach the planned target and establish their own know-how."[13] It teaches students time and resource management, and is the application of knowledge.[14]

Research Design

To understand hackathons and impact on individuals, the following research questions guided this study:

1. ***How does self-regulated learning present itself at hackathons?***

2. ***How can a better understanding of self-regulated learning outside of school contexts be useful to engineering education?***

To provide structure and to guide the design of the research, Crotty's four elements of a research study was used. Detailed in Table 1, the rationale explains how the theories and methodologies come together to build the methods in which the study was conducted.

Table 1*: Elements of a Research Study*[8]

	Definition	**Selected**	**Rationale**
Epistemology	Theory of knowledge	Constructivism Knowledge is constructed through human-world interaction (Piaget, 1967)	To understand how students learn in a hackathon environment
Theoretical Perspective	Philosophy that informs methodology	Constructionism Meaning is created through constructing and sharing artifacts (Papert, 1991)	To understand how attributes of hackathon environments affect individuals and their use of self-regulated learning through their projects during the hackathon

Methodology	Design connecting methods to outcomes	Constructivist Grounded Theory Researcher is the author of participant's voice and meaning (Charmaz, 2000, 2006)	To account for context aside from self-reports before and after the hackathon[1], observational data supplements Winne's suggested think aloud protocol
Methods	Implementation of methodology	1. Preliminary interview 2. Observations 3. Post-hackathon interview	1. To see how students perceive themselves and their learning habits prior to the hackathon 2. To observe their actions and determine how they learn and share information to provide support for their claims 3. To compare how their project utilized or changed their prior perceptions of themselves

Research Methodologies and Data Collection

Prior to conducting this study, IRB approval was sought and received in order to conduct interviews and observe hackathon participants. Following this approval, the research team reached out to the organizers of a local MLH sponsored hackathon in order to receive approval to attend and to study select participants.

While the participants of the study were not selected until the hackathon began, the criteria was established beforehand; the participants must be over 18 years of age, have consented to participate in the study, be part of the same four member team as the other participants in the study, and be collegiate students.

Interviews were developed with Winne's *Improving Measures of Self-Regulated Learning* in mind. Preliminary interviews took an average of five minutes to conduct, whereas post interviews took an average of 10 minutes to conduct. Questions were asked based on the interview protocol to gather personality characteristics, motivational reasoning, and proof of adaptability. Examples of some pre and post hackathon questions are below in Table 2.

Table 2: Pre-Hackathon Interview Questions

Question	Explanation
Name some defining characteristics of yourself or your personality.	This is to establish the interviewee's sense of self.
Why are you attending this hackathon?	This is to establish the interviewee's motivation to attend the hackathon.

Table 2: Post-Hackathon Interview Question

Question	Explanation
Did you find yourself needing to adapt to solve or figure out a problem? How so?	This was to gather introspective data on whether they felt they had to adapt at any point during the hackathon.

Table 3: Learning Observational Protocol

Code	Explanation
Data Selection	"What info is the focus of attention for team members?" What topic or skill did the team/individual decide to learn or research
Clarification for Understanding	Asking questions, asking for review, feedback loop, all are applicable examples that fall under this topic.

Table 4: *Sharing Observational Protocol*

Code	Explanation
Member Selection	Communication in the group, "who speaks and why" which team member is speaking and what information are they conveying
Sharing	The transmission of information to one of more team members through face to face conversation or through media (e.g. chat interface).

Interviews were transcribed and analyzed with Dedoose using themes developed from Winne[1] (see Table 5). Observational data was recorded in a spreadsheet as participants displayed specific actions, such as sharing information with another team member, or a participant asked a team member clarifying questions. This was used to supplement a think-aloud protocol, but also to provide the self-regulated learning context that interviews do not properly entail according to Winne[1]. To filter the observational data, Grand et al's theory process on knowledge emergence in teams discussed specific actions to look for and thus was used to develop an observation protocol (see Table 6 and 7).

Table 5 *Interview Themes*[1]

Theme	Explanation	Times Observed
Metacognition	Did they mention their thought process? Their strengths and/or weaknesses? Understanding themselves in how they did something	16
If-then-else	A way to model self-regulated learning, thought process	9
Adaptability	On the fly decision making/choices/adjustments	16
Motivation	Drive, initiative, something that spurred a person to complete/start something	16
Strategy	Planning and its effectiveness	28

Table 6 *Learning*[7]

Term	Explanation	Times Observed
Data Selection	"What info is the focus of attention for team members"	4
Encoding	How are events/information/ext. Stimuli turned to memory "learning-from-self"	3
Decoding	Interaction with info sources "learning-from-others"	8
Integration	Categorize and organize concepts (connect the dots, consult existing knowledge to sort or relational knowledge to understand)	0
Clarification for understanding	Asking questions, asking for feedback on something, asking for review (etc)	2

Table 7 *Sharing*

Term	Explanation	Times Observed
Member Selection	Communication in group "who speaks and why"	4
Retrieval	Accessing info "information a team member shares with team members"	3
Sharing	Transmitting information to 1+ team members via face to face conversation or through media (chat/etc.)	10
Acknowledgement	E.g. notes/reminders/feedback loop/etc. Signal of receiving and comprehending the information and taking it into account	3

Results

Sharing and Learning

Through our observations we noted a discussion-style learning process. When one team member brought forth information to the team as a whole or to another team member individually (an action classified as sharing) the other team members displayed actions that fell under learning-related classifications. For example, at the beginning of the hackathon, one team member suggested different programs they could use and explained their use. Depending on the program, another member would ask clarifying questions to understand its purpose or use. This also worked in reverse, where a team member would ask for help; if another member had an answer, would then go on to share information with them. This was particularly evident once the hackathon was well under way. Many of these instances occurred when someone ran into issues with a program being used or an error occurred that they did not understand, and another team member was familiar with the program or language and able to help solve the issue. In the process of fixing the error, the helping teammate would simultaneously explain why the error occurred. The data for these occurrences implied that back-and-forth communication built the bridge between sharing (past knowledge or information) and learning (new topics or refining understanding). This discussion-style learning process provides insight into the effectiveness of the hackathon environment as this team, who had never worked with each other prior, were able to find themselves at ease with providing information and learning from each other.

Problem Solving

In our interviews, a thought pattern appeared that was surprising and contrary to the expectation of the interview framework. In the preliminary interviews when asked about their approaches to problem solving, they all answered in an if-then-else format. For example:

> *If I find some issue, I just search the particular question or problem and I use more resources that I have. (B.John)*

> *I approach them with the first thing that comes to mind… then if that doesn't work then you try and start changing a few things and then if you notice that these few things that you keep changing aren't really working then I try to go about in a new direction, so just keep hit or missing, that sort of thing. Just kind of trial and error. (B.Pat)*

In the post interview, their answers on how they adapted to issues were not as clear. "I think we just [grinded] our way through it" said one team member (A.Max). In contrast, our observational data indicated otherwise. One documented conversation consisted of a problem-solving technique much like Pat mentioned: trial and error. One team member ran into an error and in order to solve it, another suggested alternative methods and proceeded to explore the options available to them.

Strategic Learning

Strategic learning became apparent as specific methods mentioned in the preliminary interviews presented themselves in the observations. The preliminary interviews provided the student's prospective on how they felt they learned. While trial-and-error was mentioned in the preliminary interview, another method, pair programming, was not explained until the postliminary interview. Max explained how he and John worked on their part of the project via "pair programming which is a way of someone is at the keyboard, but both people are putting in input in terms of design" (A.Max). Instead of having two people learn the same topic separately, the two team members sought to learn the same topic at the same time, using each other to help provide perspective and understanding to the concept. Other generalized methods included their "teammates [teaching them] a lot about swift" (A.John), and "searching from Google" (A.Dan).

Motivation

There were two types of motivation for the team: motivation for attending the hackathon, and motivation to complete the project. Underlying both goals is an interest in learning something new. Dan said they "[wanted] to learn some new technology and make more friends" (B.Dan), and Pat "[found it] important that [they] should dedicate these 36 hours to meeting new people and practicing things that would be relatable to [their] career field" (B.Pat). John also said something similar, saying that he "need[ed] to have more experience about making, designing, and even developing software… Just doing homework does not do enough for me" (B.John). In knowing why some students come to hackathons, a better understanding of the motives and desires of these students arises. Students who desire to learn come to hackathons because they have the opportunity to do so. This is likely part of how self-regulated learning came to be a part of hackathons: their desire reached a point in which they sought an environment that would allow them to learn to their utmost.

The presence of motivation in completing their project was supported in their goal statements and their task distribution. "We want to make an application that is accessible to high school students… We really want to target minorities too" (B.Max). By the end of the hackathon, goals that were implicit were vocalized in the postliminary interview. "One big thing was to simplify the problem with what needed to be done," while making sure "everyone knew what we were

working on, what parts were being worked on" etc. (A.Pat). A list was even made to help identify and distribute tasks accordingly (A.Max).

Interestingly, this is echoed by Briscoe et al, which states that "when participants were asked why they attended [hackathons] the two top reasons were learning and networking."[4]

Discussion

Self-Regulated Learning

According to Winne, self-regulated learning is when one has the ability to motivate themselves to learn something of their own will and interest, and does so. The students observed clearly displayed such characteristics. These students came to the hackathon with the intent to learn something new, or devote their undivided attention to something they were interested in. If a way to motivate students as much as these students in coursework existed, it might improve the quality of education, or spur innovation. The idea to take from this is that they came to the hackathon to act upon their desire to learn. This motivationally charged endeavor spurred them to reach out to others, or to the internet, or to find alternative solutions. Impediments became challenges in which they sought to overcome in their own preferred method.

Hackathon Attributes

A team consisting of individuals who had never previously worked with each other prior were able to come together with a common goal to complete their project. In their constant communication whether by learning or by sharing, and by discussing where they wanted their project to go, there were minimal issues of miscommunication, wasted effort, and disagreement. This hackathon spurred this team to discover how to communicate effectively with each other.

Constraints of time was a large factor in the decisions they made, and the steps they took to achieve what they desired. Time became the motivator and provided reason to concentrate enough to complete the project. It was also the first constraint already known to the participants, and started the team off in a manner that reflected this. Brainstorming happened almost immediately, debates upon a project, and subsequently how to do the project occurred. Tasks were divvied up based on skill or preference while non vocalized goals were implied amongst the group or self-assigned.

Conclusion

In this paper, we have presented methods of observation for self-regulated learning in a hackathon environment, and discussed the overarching themes that have developed from these observations. These include various already known methods such as trial and error, as well as every day actions such as googling a question. For the future, more teams should be studied to see if the phenomenon that occurred in this team are present in other teams. Future studies should also determine if all MLH hackathons provide the same environment for students to learn as they please and be driven to the completion of their project through their own determination. Essentially, more environments should be explored to understand different backgrounds of self-

regulated learning. If focusing only on hackathons, the compiled data gathered from hackathons should be used to determine if hackathon attributes, should be brought into engineering education in order to keep students invested in their project courses and increase their desire to learn and solve problems over longer durations,. Ideally, students with motivation and time driving their desire to complete a project, might refine themselves to become better learners, and find their own preferred methods of approaching adversity. The same process should be applied to other external environments to better accommodate more types of students and refine project based learning, if it is determined needed to be needed.

Usefulness to Engineering Education

The hackathon team displayed desires to learn and overcome challenges as a group. Having an equivalent mindset in a project based learning engineering design course is an intriguing extension. Seeing how such a team approaches problems over the long term might lead to more insights on project based learning. More research should be done to determine if the discoveries made with these four students occurs in other groups or not. This will allow for a better understanding of self-regulated learning. Another approach is to explore other instances of self-regulated learning in external situations in order to determine the different ways self-regulated learning manifests in different environments.

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