

LEARNING TO MAKE:

LOWERING BARRIERS TO ENTRY FOR NOVICES AND SUPPORTING COMMUNITY ENGAGEMENT THROUGH A CONTEXTUAL USER INTERFACE

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ABSTRACT

Theories of learning describe the importance of working in a social context to acquire resources from peers. For online creative communities—where ‘making’ is the shared interest—members participate and engage in the production of physical and digital artifacts, develop their creative skills, share their process, and seek inspiration and advice from others. Most online platforms designate a separate section (or sections) for a specific type of member—the ‘newbie’ (i.e., novice). Newbies, however, come from different places in their learning goals and hold different levels of knowledge and experience. Nevertheless, they are often lumped into the same ‘beginner’ category—by other community members, as much as through the design of a ‘one size fits all’ user interface. Although considered beginners, novices learn at different rates and have different engagement strategies and help-seeking needs. Thus, it is important to acknowledge these differences through a more user-centric, contextually responsive design. While HCI designers use tools such as recommender systems, among others, to help acculturate beginners to the community, nevertheless newbies often fail to participate for various reasons: some social and psychological (such as fear of contacting someone older or more experienced); some technological (such as unfamiliarity with ‘community structure’ or the user interface features and tools).

This research identifies a conceptual framework—a ‘Novice Gradient’—that expands the generic definition of ‘novice’ to inform the design of a context-sensitive user interface. The goal is to lower novices’ barriers to participation and present information in ways that support community engagement in an online space. Contextual interfaces can help ease novices into their domain by supporting their learning goals while tailoring communications in a way that helps them engage with other members, no matter their status or knowledge level; context-sensitive tools can help novices build upon their ‘making skills’ while simultaneously supporting their help-seeking and ability to reach out. Designers can create contextual interfaces that take account of what it means to be ‘novice’ in an online community, thereby supporting beginners as they become fully participating members of their communities.

My research methods include exploring and developing different scenarios and personas based on information from semi-structured interviews and observations of live ‘Maker’ events. There are three visual studies organized around the design of contextual-sensitive interfaces, community communications, and strategies for facilitating learning goals. Each study explores a contextual interface that scaffolds the beginner’s level of participation, incorporates tools for different types of novices, and encourages participation and knowledge sharing.

Through visual studies, this investigation explores how a contextual interface design can support novices as they learn a computer programming language—Processing—by tailoring information necessary to learn and engage with other members. This study concludes that the necessary tools, functions, and features for each novice level to fully participate in the life of the community need to be different from those of more experienced community members. While some tools, functions, and features are available in each of the three novice levels, the designs presented in this study still tailor presented information for each specific level of novice. For instance, a video tutorial feature (timeline tools) and a vocabulary feature (dictionary tools) are available in each novice level, however the information and content for each tutorial and term accommodate the different needs and goals of each novice level. Moreover, this research concludes that an interface that can adapt to a novice’s goals and interactions is beneficial. Most importantly, it is crucial that online developers acknowledge different types of users in the design of their systems—especially the novice level—because each user requires different kinds of information and different degrees of help while participating in online platforms. Thus, the context-sensitive user interface can serve an important role in tailoring information and providing meaningful learning experiences for all user levels.

BACKGROUND AND INTRODUCTION TO THE PROBLEM

BARRIERS TO LEARNING IN SOCIAL CONTEXTS WITH TECHNOLOGICAL SUPPORT

Not only in the classroom, but also in sociocultural practice, learning is becoming more of a group activity, especially in problem-based or inquiry-based situations, and moving away from traditional ideas of the individual learner (Järvelä et al., 2015). Many theories describe the importance of the process of sharing in collaboration. Järvelä et al., for example, maintain that collaboration is the construction of shared understanding through interaction with others, where participants are committed to, and engaged in a common goal of problem solving (Järvelä et al., 2015). Through interactions with others—especially in an online learning community—people share their knowledge, learn from, and connect to others, which helps maintain a high motivation level. As technology became more accessible and its tools more powerful, it now mediates the social interactions between people and supports them in many situations, including learning. People from different locations can now communicate with, as well as learn from, anyone, anywhere, and anytime, therefore learning has become as much a social process as it is a cognitive one.

Since learning is an active process—not just the simple transition of information from instructor to student’—group learners construct new understanding with each other through active exploration, experimentation, discussion, and reflection (Resnick, 2002). This process is also dependent on the learning environment, which requires learner ability to access pertinent information in a timely manner and lowering possible barriers that may arise in social situations. When learning is situated in a social context and mediated by technology, different barriers arise—some related to entering the social context (such as an online community), others are related to the technology itself (such as familiarity with using a computer). According to the technologist Seymour Papert, several cultural and political barriers hinder people — in his case, children — from knowledge construction that need to be addressed (1993). Cultural barriers, such as isolation and fear of making a mistake prevent people from learning. One example of political barriers that Papert mentions is how people perceive artifacts of knowledge construction as something that belongs to others, rather than something instead of making and tinkering with it, though they grow up with it. Papert maintained that technology—especially personal computers—could be a carrier of powerful ideas and the seeds of cultural change (1993).

JUSTIFICATION

Online learning communities are diverse groups of people who come from different locations, different cultures, and different social statuses. This thesis project concerns a specific type of online learner: the novice. Though novices also share the same interests as others in their learning communities—i.e., the domain of practice—they have different needs than other, more experienced members of the group. Specifically, novices need support not only for their learning goals, they need support and guidance for group participation activities; and this need becomes even more crucial in an online environment (Wenger, 1998). Since online community platforms lack the richness of face-to-face interaction, novices face more challenges in finding information that suits their needs and levels of expertise. Furthermore, current interface design strategies tend to generically lump all novices into one ‘beginner’ category. Beginners (also called novices or newbies), however, have different knowledge backgrounds and experiences in two regards: 1) their experience with online social interactions, and 2) their level of domain knowledge (Dreyfus, 2004). Some beginners are more comfortable requesting help or reaching out to other, more experienced members; other beginners simply struggle to hit the ‘Post’ button on that first “Hello! My name is...” message. Novices also have varying degrees of domain knowledge in both subject matter and familiarity with the ‘tools of the trade’ (including technology, as in the case of this thesis project). Thus, it is important for interface designers to consider the user’s prior knowledge and experience; the user interface contributes to how fast novices learn and how the system appropriately eases new users into the community (Cockburn et al., 2014). Designers can create interfaces that adapt to different member levels and help lower barriers to participation.

This thesis investigation examines an online creative community where ‘making’ is the shared interest (i.e. the Maker community). In a general sense, the Maker community is a group of people who are involved in the Maker Movement, whose goal is to learn how to creatively make or build artifacts that are meaningful to them. Members in this “Community of Practice” (Lave and Wenger, 1991) engage in the production of physical and digital artifacts, develop their creative skills, share their process, and seek inspiration and

advice from others. In processes of participation over time, members build a shared repertoire of information, advice, tutorial, and project galleries, among other resources. The purpose of this thesis investigation is to understand how a user-centric, contextually responsive interface can support different levels of novices as they navigate an online Makerspace and peruse its shared repertoire of resources. Towards this aim, the research identifies a “Novice Gradient” (i.e., conceptual framework) to inform the design of the information architecture and user interface. The overall goal of this thesis project is to lower novice barriers to participation and present information in a way that supports their engagement with learning tasks. Contextual interfaces can help ease newcomers into their domain by tailoring information necessary to engage with other members, no matter their status or knowledge level; contextual interfaces can also facilitate learning goals while simultaneously supporting help seeking and the ability of novices to reach out. The prototypes demonstrated in this thesis project take account of the nuances of ‘what it means to be a novice,’ by supporting them in the process of becoming fully-participating members of their online learning communities (Lave and Wenger, 1991).

CONTEXT AND CONDITIONS

'Making' is not a new practice; people have been making and building before the Internet came along. 'Crafting', in association with online communities today, refers to the same practices involved in making and building. Historians trace both phenomena back to the Arts and Crafts movement of the 19th century, whose members included a group of idealistic thinkers and crafts people inspired by the ideas of John Ruskin and William Morris. According to sociologist David Gauntlett, the Arts and Crafts movement was founded on the principles of the human creative spirit, authenticity to materials, and the politics of work—i.e., that all creative work is equally worthwhile because it makes human beings connect with nature, with their own sense of self, and with other people (2011). Not only does 'craft' reflect one's idea of 'self', it also reflects the skill; skill is valued for its own careful, individual, handmade beauty—and not that of an expert elite. Thus, the idea of 'crafting' embraces the process of making rather than the adulation of the finished artifact.

The Arts and Crafts movement has been inspirational for the 'DIY' (Do-It-Yourself) movement today. The phrase do-it-yourself is often associated with the belief that people can do things better themselves, and they do not require any proper training from institutions or formal education (Gauntlett, 2011). Educational scholars support the idea that learning is an innate process—something that we do naturally. According to research, assignments designed to force learning as a specific activity—e.g. teacher-dictated formal assignments—presents a barrier to learning by means of everyday life experiences (Gauntlett, 2011). Not only does learning occur naturally, learning is a process of construction, where learning involves "building knowledge structures irrespective of the circumstances of the learning" (Blikstein). In other words, people learn best through the act of making. This notion has become the founding mantra of collaborative learning environments such as the Makerspace (Hamidi and Baljko, 2015). The process of making is meaningful in terms of connecting people to objects, people to people, and people to their social and physical environment (Gauntlett, 2011). Thus, the process of 'making' allows people to connect the things they make together with others to not only learn, but to create something new. This type of making involves a social dimension; through making and sharing things in the world, people become more engaged with their social and physical environment — with the ideas and the knowledge learned through the practice of making (Gauntlett, 2011). In the context of this thesis investigation, it is important to note that 'learning to make' is different from learning in a traditional educational environment. Undeniably, learning to make is an appropriate approach in formal education settings, however this investigation examines the concept of 'learning to make' as a self-directed process, where the production of artifacts is more akin to a 'hobby' or a 'passion'. In sum, educational researchers argue that learning to make is a way to build understandings so that learners can create their own meaningful connections to the knowledge they learn. As Gauntlett explains, these scholars argue that learning to make is a more useful and

effective strategy than the abstract pile of procedures and information that is commonly found in support of formal school learning (2011).

The Maker Movement is a recent social phenomenon that generally refers to people who participate and engage in the production of artifacts and who share their making processes with others. The accessibility of technology, like the Arts and Craft movement, influenced this movement. The characteristics of Maker culture relates to the collective community practices of making, sharing, and collaborating with the influence of technology. The Maker Movement combines physical and digital components – the new technology with the hand-skills and processes of making. Specifically, makers are encouraged to take up an active role in the design of the artifacts they use (Willett,2016) where people gather and learn the process themselves. Underlying themes include the democratization of the tools for making, and encouraging a participatory culture while collectively forming knowledge throughout the community. In essence, the Maker Movement focuses on learning through making and a spirit of sharing and collaborating.

CONCEPTUAL FRAMEWORK

ASSUMPTIONS

Before discussing the conceptual framework, I want to address some assumptions that I made regarding the novices and the frameworks used, which are *Community of Practice*, *Activity Theory*, and *Five-stage Model of Adult Skill Acquisition*.

First, I assume that the novice has some interests in the new domain. When the novices enter the new community of practice, I assume that they can self-identify and reflect on their background experience whether they have similar background experience as the new domain.

Second, I assume that level of participation is the same as level of engagement/interaction (external), which reflects level of motivation (internal). The level of participation is measurable through the frequency of communication (how often the novices interact with the community). Since I assume that novices are interacting with the community, the level of participation can determine where the novice is in the participation gradient of the community of practice.

Lastly, I assume that the main activity of the novice in this investigation is becoming part of the community—more involved in the community.

LIMITATIONS

To ground these frameworks and the Novice Gradient, this investigation will look at Processing as one application. I assume that Processing (as the case study to ground this investigation) constitutes a real social online learning community, which its new members log in, and join the community. Since this investigation addresses only the learning and community in Processing, it may not be relevant to other social learning platforms, but it is possibly useful for other 'learning to programming' platform. I also assume that there are novices using Processing and they use it as a repository for learning Processing language as opposed to the textbook.

FRAMEWORKS

The conceptual framework informing this investigation is based on Lave and Wenger's notion of 'legitimate peripheral participation' in a 'community of practice' (see Figure 1). A community of practice is a system of interrelated forms of participation, where members come together through a shared interest. In a community of practice, newcomers move from 'partial participation' to 'full participation' as they become more engaged in the community in a process called 'legitimate peripheral participation' (ibid). By moving toward full participation, novices engage and learn not only how to perform the shared 'practice', they also learn about the 'community'—including how it is structured and norms for acceptable behavior. For novices, learning how the community culture 'works' is a crucial first step in their acceptance by others in the group as active, fully participating members.

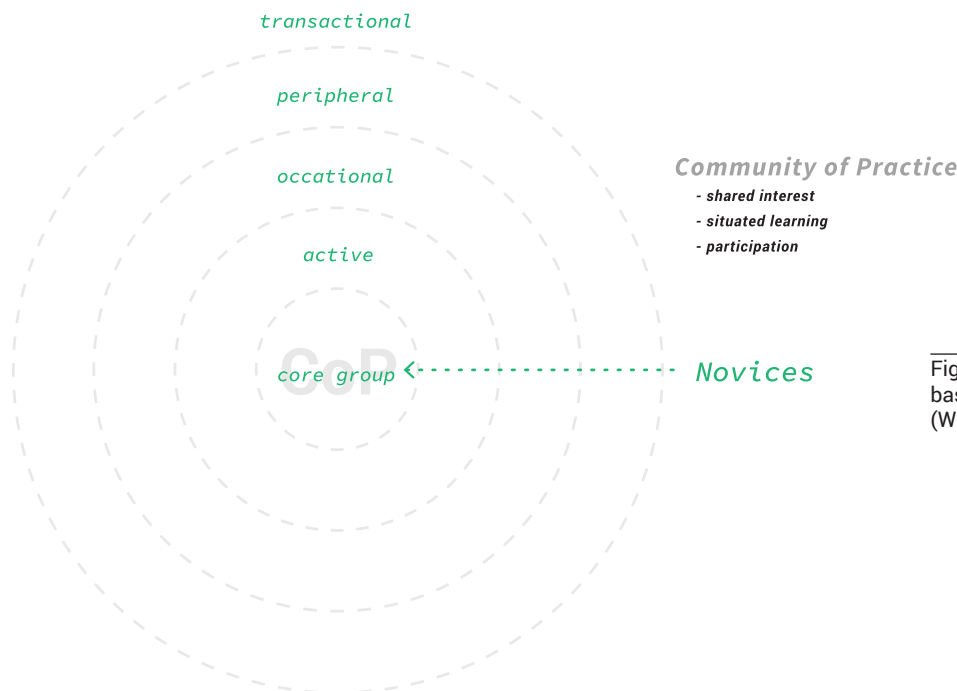


Figure 1: Community of Practice diagram based on Wenger's *levels of participation* (Wenger-Trayner and Wenger-Trayner, 2011)

Activity theory (Kaptelinin, 2006) describes how a person's past experiences play an important role in considering how the use of, and interaction with, tools changes over time. 'Activity' is a fundamental concept in activity theory, which is the purposeful interaction among subject, people, and the world (Kaptelinin, 2006). Through analyzing the process of activities, activity theory seeks understanding of individuals and social entities in natural circumstances. By examining 'activity,' researchers can understand both subject (an individual or a

group of people) and object (the system or artifact that is associated with the activity) in social and cultural contexts (ibid). Since novices are interacting with each other through a digital medium—in this case, the contextual interface—activity theory informs the goal of this thesis. Specifically, activity theory allowed me to understand how people interact with their online environment through the tools they use—and how their interactions and tools need to change over time and adapt as novices incrementally gain experience and ‘know how’.

When subjects engage in activity, they do so in ways that move them toward their predetermined goal (Wilson, 2006). ‘Goals’ in activity theory determine different activities and are associated with user motives in that motives lead every conscious activity. Each activity results in some sort of feedback, which might not always directly satisfy the goal, but is led by the motive to assist future activity (ibid). This ‘feedback loop’ in activity theory contributes to the historical context of the activity that informs the individual’s perspective and changes the individual’s motives and goals. Since the subject of the activity can be a person or group of persons, the activity can be shared or collaborative in that people work together to achieve some predetermined goal (Wilson, 2006). Shared activity introduces the concept of community, which is part of the cultural context.

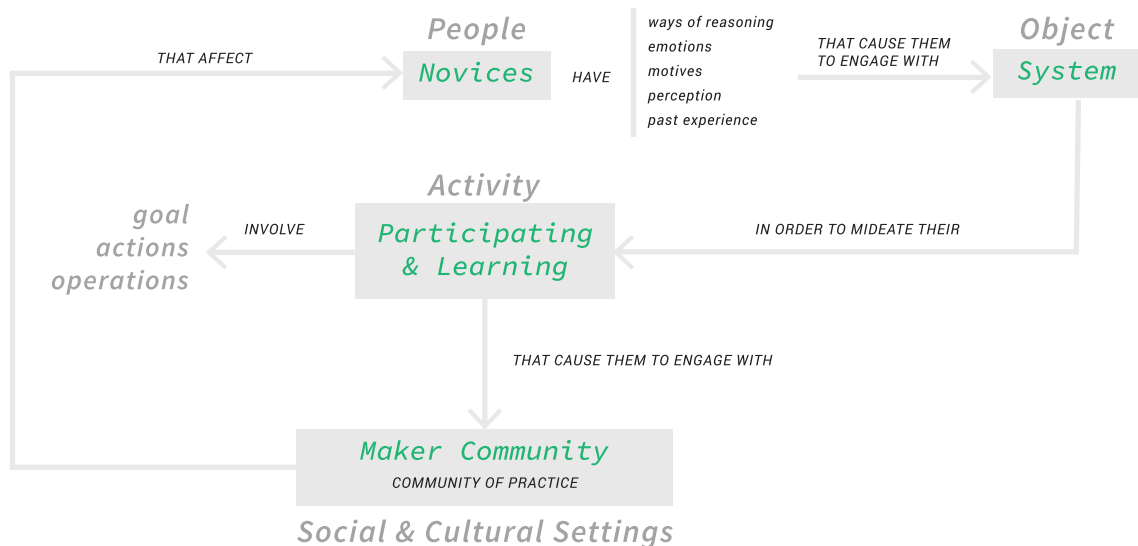


Figure 2: Activity theory diagram based on Meredith Davis' discussion in *Graphic Design in Context: Graphic Design Theory*

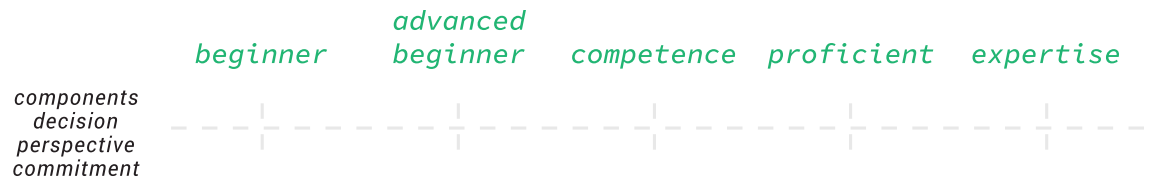


Figure 3: 5 stages of adult skill acquisition based on Dreyfus' discussion in the *Five-stage Model of Adult Skill Acquisition*

Educator Stuart Dreyfus' "Five-Stage Model of Adult Skill Acquisition" informed this study as a model for the new Novice Gradient. Dreyfus' model describes five stages that learners advance through, from novice to expert—beginner, advanced beginner, competence, proficiency, and expertise. Each level is characterized by the differences in components, perspective, decisions, and commitments of the person at each stage (Dreyfus, 2004). During the novice stage, the information an individual is learning is taken out of context, which allows beginners to recognize the knowledge without any desired skill (ibid). The beginner simply follows the rules. However, if beginners simply follow rules, they will perform poorly in 'real world' situations because they do not understand the context in which the information makes sense (Dreyfus, 2004). For example, if a chess player who always exchanges to gain points did not know about other player sacrificing to gain more advantages, the chess player who always exchanges would lose (ibid). At the advanced beginner stage, the novice gains experience for coping with real situations; the novice begins to understand the relevant context and notice new aspects of the situation (ibid). Even though the novice gains more understanding, he or she still relies on analytic reasoning that is detached from the learning. After gaining more experience and moving towards the 'competence' stage, learners begin to notice more potentially relevant elements, and the danger is that they become overwhelmed. They become afraid to make mistakes. So, they will avoid them by seeking for rules to justify their reasoning. During this stage, failure and confusion often influences to the learner's perspective (can be positive or negative) and experience. For example, if the trainee did not stay emotionally involved with the job (both joy of the job and remorse of mistakes), he or she will not develop further (Dreyfus, 2004). Emotional involvement plays an important role in moving forward to further skill advancement (Dreyfus, 2004). At the proficiency stage, the learner has enough information and experience. Then, they form their goals that they want to achieve from their prior information and experiences but they do not know how to go about it (Dreyfus, 2004). This was because the learner did not have enough experience with outcomes of different responses of each situation. At the expertise stage, the learner is immersed in the environment and activity. The learner knew immediately how to react or achieve the goal. The ability to determine or carry out the response intuitively was what distinguished the proficiency stage from the expertise stage (Dreyfus, 2004). Thus, the four aspects that determined each stage are context of the situation, perspective that the learner developed, type of decision that the learner made in each situation, and the commitment to the learning.

THE NEWBIE GRADIENT

The conceptual framework for my research identifies different types of novices, based on the three aforementioned conceptual frameworks—community of practice, activity theory, and Dreyfus' Five-Stage Model of Adult Skill Acquisition. This Novice Gradient defines three types of novice: newbie, novice, and advanced beginner. Novices hold different past experiences that inform where they are in the gradient since past experience influences how the novice approach the current situation according to the activity theory. The three types of novices are differentiated by the following characteristics:

The newbie is someone who has no prior knowledge or experience with the domain that is similar to the current domain.

The novice knows somewhat about the current domain based on past experience with a similar domain.

The advanced beginner is someone who can transfer or apply his or her prior knowledge or past experience to the current situation.

This conceptual framework and the Novice Gradient were applicable to different online learning communities. However, to ground the framework, I developed scenarios and personas of different types of novice and explored the tools/function/feature and information needed to lower barriers to entry for learning Processing. I also explored ways to incorporate community elements and strategies that would help easing and encourage the user in participating in the community.

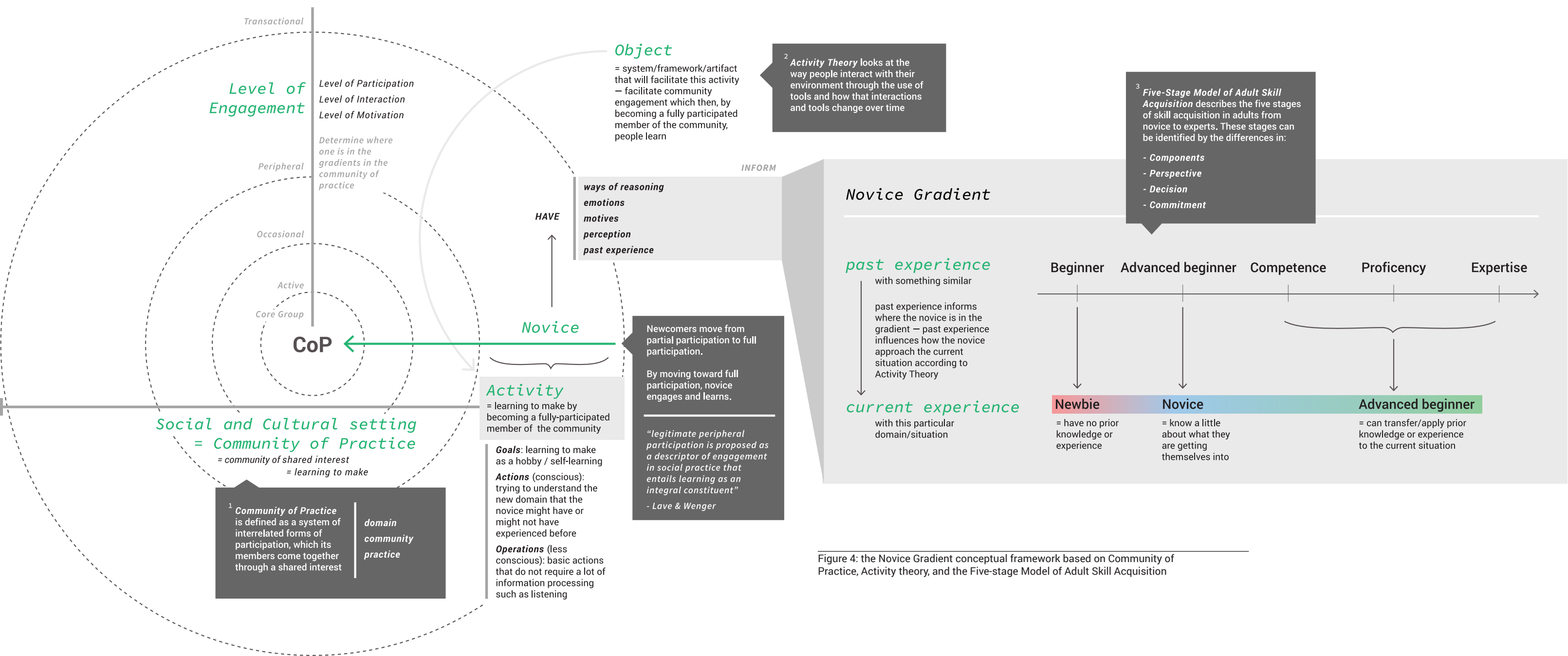


Figure 4: the Novice Gradient conceptual framework based on Community of Practice, Activity theory, and the Five-stage Model of Adult Skill Acquisition

RESEARCH QUESTIONS

MAIN QUESTION

How can the design of an online learning platform facilitate the learning to make by lowering barriers to entry for self-learning novices and support the community engagement through a contextual user interface?

SUB QUESTIONS

How can the design of a contextual user interface incorporate visual strategies and tool/function/feature that are appropriate for different novice level?

How can community generated content or data be designed to further encourage users to participate in learning and sharing?

How can the design of a contextual user interface incorporate strategies for facilitating learning to make and supporting community engagement?

DEFINITION OF TERMS

Self-motivated learners

In this investigation, self-motivated learners refer to people who show initiatives in learning. They are motivated and driven to learn or interested in learning new skills. Since self-motivated learners usually take initiatives toward learning new skills, they are assumed to have some expectation for the use of the new skill. There are different types of self-motivated learners. However, this investigation focuses on the novice makers, which are people who want to be involved with the Maker community, as the self-motivated learners. These individuals are interested in learning new technology. In other words, they have some expectations for learning new skills.

Context-sensitive user interface

Context-sensitive interface or adaptive user interface refers the adaptation of the user interface based on user's environment, such as device, activity, and etc (Paterno). The context-sensitive user interface can tailor specifically information towards users, regarding the users' current situation.

LITERATURE REVIEW

COMMUNITY OF PRACTICE

According to Wenger, what makes a Community of Practice is a system of interrelated forms of participation (1998). When people who share a common interest come together and form groups, they learn from one another through regular interactions that involve knowledge sharing; Wenger refers to these groups as 'communities of practice' (2015). According to Wenger, people move through and become part of several communities of practice in their lifetimes. Three characteristics that define a Community of Practice are the domain, the community, and the practice (Wenger-Trayner). The domain is a shared interest that members have in common. It distinguishes members from other people. The community is the sociocultural space where members interact with each other by engaging in joint activities and discussion, helping each other, and often sharing information (Wenger-Trayner 2015). The members of a Community of Practice are practitioners. In other words, members develop shared resources, such as experiences, tools, stories, and ways of addressing problems (ibid). These shared resources become a valuable repository that newcomers access, and then later, make new contributions to, as they become more active in their participation. In each Community of Practice, there are "generational discontinuities" when newcomers join the community, whereby relative newcomers become relative old-timers (Wenger, 1998, 90). Beginners, or newcomers as Wenger calls them, require learning during an initial period in the community in order to be "legitimized" and be treated as potential members (Wenger, 1998, 99-101). Thus, beginner learners are inexperienced people in that particular community.

SITUATED LEARNING: LEGITIMATE PERIPHERAL PARTICIPATION

In a Community of Practice, a person engages his or her intentions to learn through the process of becoming "a full participant in the community," whereby meaning is constructed through that same process (Lave and Wenger, 1991, 29). Thus, learning is an integral part of a social practice when newcomers move from partial participation to full participation. Lave and Wenger describe this process as "legitimate peripheral participation" (ibid 1991: 29). Legitimate peripheral participation looks at the relations between newcomers and old-timers, such as their activities, identities, artifacts, and communities of knowledge and practice (Lave and Wenger, 1991, 29). Peripheral participation means that the actor is part of the social world where changing in locations and perspectives are part of "learning trajectories, developing identities, and forming relationship or membership" (Lave and Wenger, 1991, 36). "Peripherally" suggests that when the

actor becomes more involved in the community, he or she gains access to more resources for understanding. However, it is critical to understand that “legitimate peripheral participation” does not refer to an educational form, pedagogic strategy, or a teaching technique (Lave and Wenger, 1991, 40). It is just another view on learning that happens during growing participation. Learning happens naturally at the same time while learners move from learning at the periphery to legitimate peripheral participation as they connecting to the community.

MAKER COMMUNITY

Some scholars refer to the “Maker Movement” as a community of makers who are “connected through shared interest in creativity, inventiveness and sharing knowledge” (Hamidi and Baljko, 2015, 53). Thus, the shared interest is the act of making that encourages creativity and exchanging knowledge. Similarly, some scholars include the involvement of technology as a characteristic that differentiates the Maker Movement from other movements such as the Arts and Craft Movement or the Do-It-Yourself (DIY) Movement (Fourie and Meyer, 2015; Halverson and Sheridan, 2014). The scholars define the Maker Movement as a group of people who are “engaged in the creative production of artifacts in their daily lives and who find physical and digital forum to share their processes and products with others” (Halverson and Sheridan, 2014, 496). The Maker Movement does not only concern a culture of learning and sharing, it involves active production—the ‘making’ aspect of the Maker Movement. As processes of ‘making’ shifted during the Industrial Revolution from handcraft to manufacturing, production of artifacts became more complex and inaccessible to the everyday person. Consumers became disconnected from actively participating in the production of the artifacts they used in everyday life. Currently, however, the decreasing cost of technology (according to the Moore’s Law) enables the Maker Movement; it provides a platform for consumers to take up active roles in the design of the products they use. The rise of digital technology in the late 20th century has removed many barriers to entry, along with increased social connectivity afforded through the Internet, Maker Fairs, and Makerspaces (Hamidi and Baljko, 2015).

The current ‘Maker culture’ has become a means to express creativity and encourage individuals to participate and collaborate. It led to the creation of Makerspaces, sometimes called FabLabs, which are available in educational institutions and communities, including science museums, high schools, and colleges. Makerspaces engage audiences by combining new technologies and old forms of communication and instruction (i.e., ‘face-to-face’) to transform educational spaces as social places for hands-on creative activities (Fourie and Meyer, 2015). Hamidi and Baljko

(2015) investigates the framework of the Makerspace by analyzing the role of the 'facilitator.' The authors conducted several workshops based on their framework called maker atelier. In their research, they derive their maker atelier framework from the traditional artist atelier. They define a maker atelier as a model to "facilitate the design and implementation of self-directed maker projects that combine making and tinkering with reflection and community collaboration" (Hamidi and Baljko, 2015, 49). Throughout the workshops, facilitators have the role of 'experienced maker' who, rather than teaches, facilitates the learning by providing examples, discussing previous knowledge from existing projects, ideas, and structures. Not only does the facilitator help participants, he or she also participates in the workshop by discussing, researching, and asking for feedback and support from participants (Hutching and Martin 2014). Makerspace workshops provide the richness of face-to-face interactions and communication, where participants receive immediate responses while having a knowledgeable and reliable person from which to seek help. There is a variety of workshops to choose from, usually based on the participants' interests. Notably, Hutching and Martin observed a shift in roles between participants and facilitators within the duration of these workshops. Thus, the maker atelier approaches learning by mentoring, building community, and encouraging collaboration—rather than taking control over disseminating information, as found formal educational processes, such as teaching.

CONTEXTUAL USER INTERFACE

Contextual interface is a context-sensitive interface or adaptive user interface that is tailored specifically towards users (Yang et al., 2016). Adaptive user interfaces, according to HCI researchers, are learning systems that reduce navigation and selection effort (ibid). Contextual interfaces automatically adjust content, layout, or visual presentation based on context, task, or demands to address user needs through machine (ibid). In this thesis, the contextual interface targets users' current skills and comfort levels in order to help lower barriers to entry in an online learning space.

According to Cockburn et al., graphical user interfaces too often trap users into a 'beginner mode' of operation; interfaces designed for experts, on the other hand, allow high levels of performance, but only after extensive training (2014). For example, the 'shortcut' interaction would only make sense to the experts who have used the shortcuts feature extensively. Psychologists often associate learning and skill acquisition with functions of memory, which is the repository for human experiences and understanding; what is learned is encoded in some form of memory (Cockburn et al., 2014). Thus, new skill development should be consistent

with the experiences and understanding of the human user. For example, switching to a completely new interface method is likely to cause slower performance. Thus, to improve and support transition from novice to expert, the interface should consider four domains: (1) intramodal improvement, (2) intermodal improvement, (3) vocabulary extension, and (4) task mapping (ibid). The intermodal improvement concerns the rapidity and magnitude of performance improvement with one particular interactive method such as making an interface method visually noticeable can improve performance (ibid). The intermodal improvement looks at ways to assist users in switching to faster methods. For instance, if the interface encourages users to reflect on their performance, it could also encourage users to try other faster methods. In this thesis study, for example, the 'vocabulary extension' looks at ways to help broaden users' knowledge. Two important parts of vocabulary extension include the generation of good recommendations and the presentation of the recommendations (Cockburn et al., 2014). Presentation should not only adapt to the user's context, but its presentation should be in an ambient form that does not interrupt task execution. Further, according to the authors the means of generation should produce recommendations that are new and useful for the user's current context (Cockburn et al., 2014). Task mapping considers higher-level issues of strategies that users adopt when seeking to complete tasks (ibid). For example, 'gamification' strategies can increase user engagement and performance; involving the community in the presentation of recommendations can increase the accuracy of information (Cockburn et al., 2014). Nonetheless, these four elements should avoid interrupting and breaking the flow of work.

METHODOLOGY

DESIGN METHODS

My design methodology for this investigation began with a Literature Review that partitioned the problem space into different subject areas, including Community of Practice, Makerspace Community, and Contextual Interface. From the Literature Review, I devised a conceptual framework that includes a more nuanced rendering of 'the beginner', in the form of the ***Novice Gradient*** (see Figure 4, pg. 21). I further researched existing online and face-to-face learning platforms to understand current information structures and the various tools, functions, and features in those platforms that assist novice learners. To enrich my understanding of the Makerspace experience, I also attended live Maker events to perform observational studies. In addition to the observational studies, I conducted a semi-structure interview with the facilitator of the event, as well as several unstructured interviews with event participants. From that information, I created user journey maps, which informed the various 'sticking points' (i.e., difficulties) of the participants and reflected on the differences between being present in a physical space compared to a digital space. As a case study, I also explored the learning experiences on the Processing.org website. This information helped create the scenarios and personas for this study, which in turn, informed the visual studies and prototypes. Thus, my design methodology includes:

- Conceptual framework
- Precedents
- Interviews
- Observations
- User journey map
- Case study
- Personas and Scenarios
- Visual Studies

INTERVIEWS

From my interview with one of the Makerspace event facilitators, I concluded that the role of Makerspace was to provide equal opportunities for students with library access—comprising the informal educational community—and to provide access to resources that fit their needs. In this case, most of the Maker events focused on ‘the beginner.’ Thus, the information provided in any Maker event pivoted towards basic information that would help participants to ‘get started.’ The facilitators not only provided information, but also offered basic hands-on activities so that students are able to complete the learning tasks within the proscribed time. The facilitators believed these hands-on activities help lead students to take the next step, which meant that students would become curious and find out more information on their own. Thus, the Maker events ultimately aimed to empower participants to explore ‘how to make’ on their own, which would ultimately increase the students’ creativity and inventiveness. The facilitators believed it was important to think of everyone as a beginner, because individual will always be a beginner in different areas, even if they have already had some experiences in some other area. Therefore, providing the basic information allows self-motivated learners to explore further.

Even though the basic information provided by the Maker events was important for participants, most of whom were ‘beginners,’ some participants faced several barriers during the event. These barriers varied from individual to individual. For example, one participant was not satisfied with receiving just the basic information. The individual felt like she needed information that was more beneficial and specific to her project. Some participants wished that tasks during the hands-on activities were more interesting or related to their interests instead of being a generic activity. However, all felt that having the facilitator present at the workshop was important because they could get immediate answers and help.

OBSERVATIONS

Many Maker events had the same structure. The structure included the Introduction phase, where the facilitators introduced themselves. If the events were big, the participants did not get to introduce themselves. If the events were smaller (less than 20 participants), the facilitators would ask the participants to introduce themselves. Usually the facilitators requested that the participants mention their background, which was the participants' academic backgrounds, in most events. The next phase was introductory to the event. For instance, the facilitator addressed how the event comprised of two parts: the presentation and the hands-on activity. During the Presentation phase, the facilitator presented basic information specifically targeting beginners. The basic information usually concerned explaining the common terminology for that event. For example, while the facilitator introduced the subject of the sewing machine, she had to explain all the terms related to the sewing machine so participants would have common terms that all could communicate with. Sometimes the facilitator would ask participants to complete small quizzes, or ask if anyone had questions. Notably, the facilitators often used casual language, thereby creating a friendly environment. During hands-on activities, the role of participants sometimes changed. For example, participants who had more background knowledge often helped the other participants who were unfamiliar with the topic of the event. When the participants helped others, they took on the role of facilitator for that amount of time.

PRELIMINARY FINDINGS

OVERALL FINDINGS

Preliminary findings were derived from observations at different live Maker events and from interviewing the people who joined, as well as organized the event (see Figure 7 on pg. 39). The information disseminated during the events was created specifically for beginners. However, each novice had different background knowledge and experience about the domain. Thus, they learned at different rates and their learning experiences contributed to different emotions, levels of participation, thinking processes, and engagement. For example, participants with no experience often felt 'overwhelmed,' even with the basic information. Meanwhile, the participants with some background knowledge often felt less interested in the basic information. Hands-on activities provided the best opportunity for participants to be engaged in the information and environment. These activities also provided opportunity for interacting with other people, such as asking questions, requesting help, as well as tailoring specific information for the needs of individual participants. Thus, the face-to-face interactions within these live Maker events supported the novices in their learning goals more effectively than online platforms, because novices could receive immediate responses that were tailored specifically to them if they chose to ask questions.

Although many online creative community websites investigated in this study included a section dedicated specifically for novices, novices were always lumped together into the same 'beginner' category. Since the online community websites lacked the richness of face-to-face interactions, novices faced more challenges in finding information that suited their needs and goals—all of which depended on their different background experience. Novices were also reluctant to reach out and request help from other members in their online community. Thus, the prototypes produced in this study address the important question of how to better accommodate the novice learner.

USER JOURNEY MAPPING AND STICKING POINTS

This user journey map was based on observations and talks with participants in different live maker events.

At each phase, the participants had different thoughts and emotions which derived from their familiarity with the current situation. For instance, when the facilitator disseminated information about the structure of the workshop, if the participant had been to the workshop organized by the people in this workshop, the participant knew what to expect. In contrast, if the participant had never been to any of this workshop, even learning the structure of the workshop could be overwhelming because the participant did not know what to expect from each phase of the workshop.

STICKING POINTS

Because participants have different backgrounds and familiarity with the domain, information at each phase contributed to their emotions and thoughts. Participants who were familiar with the domain felt bored or became uninterested because the information they received was redundant. However, for the participants without prior knowledge and experience, the redundancy of information can help them become more familiar with the domain. For instance, the terminology was important basic information that all beginners without prior experiences need to know. Clearly, that basic level of information is crucial for beginners; however, because all beginners have different interest in any given domain, it is also important to consider providing different levels of information tailored for each learner.

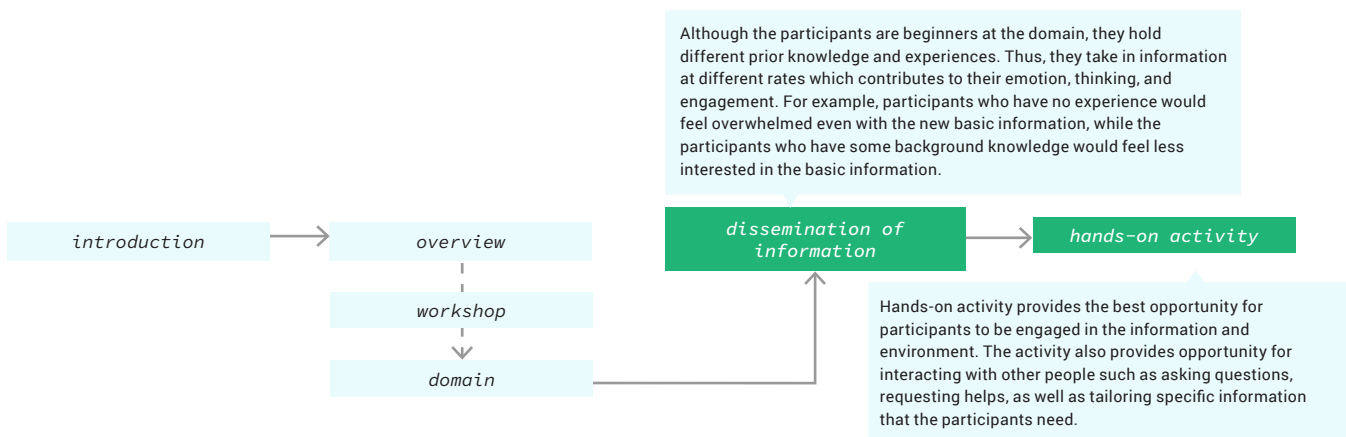


Figure 5: the general structure and flow of the current maker events (especially the workshops organized by the Makerspace)

USER JOURNEY MAPPING

facilitator

phase

participants

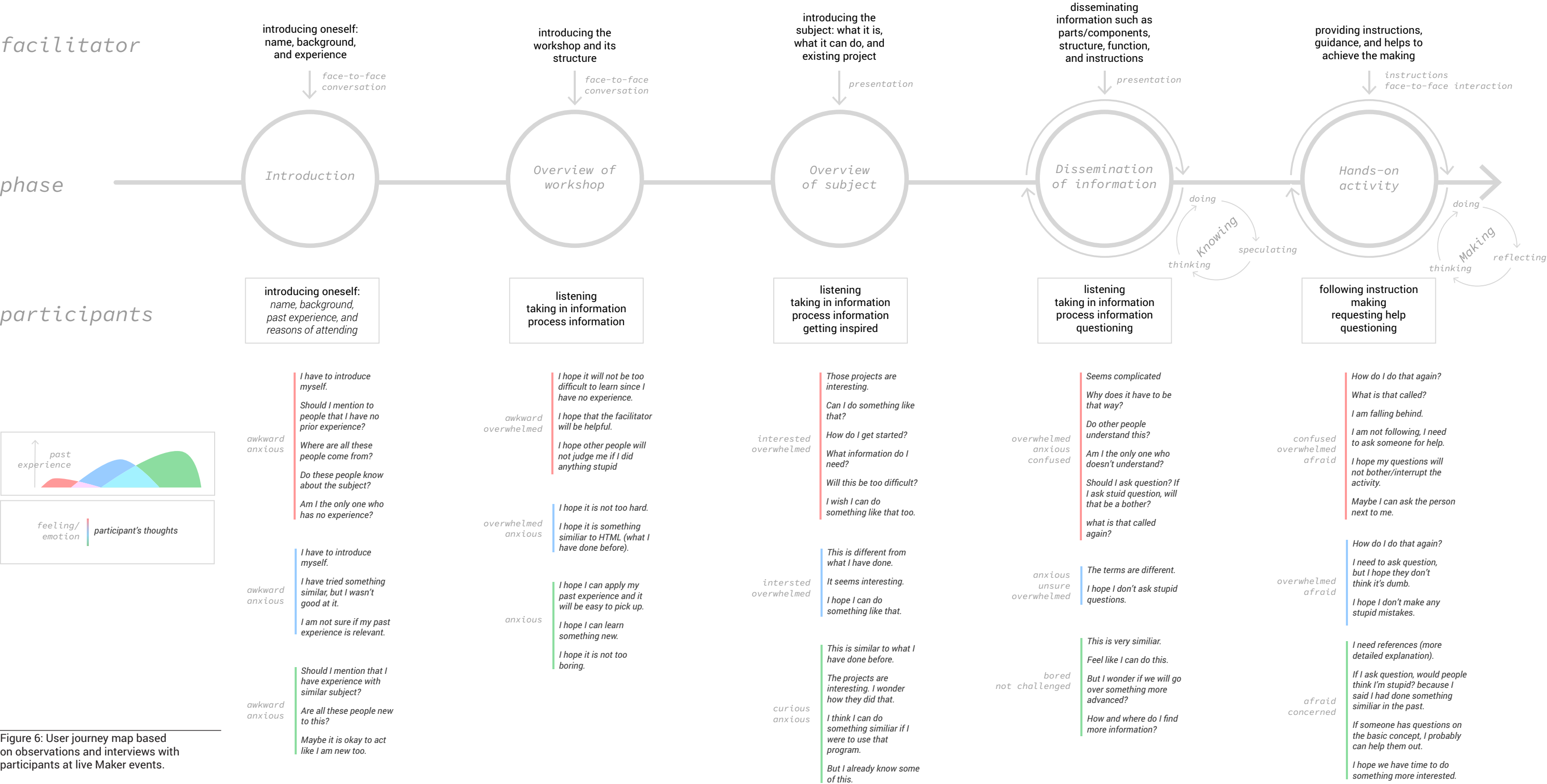


Figure 6: User journey map based on observations and interviews with participants at live Maker events.

PRECEDENTS: ONLINE LEARNING COMMUNITY

Several existing online platforms provide resources for learning and making. To understand how the current systems of online learning platforms work, this investigation considered different precedents, categorized into three types of online platforms (see Figure 5). The first type of online platform discussed in the following section is the online learning website, which strictly focuses on 'individual learning.' The second type of online platform, the online learning and sharing website, focuses on both learning and 'community engagement.' Lastly, the third type of online platform, the online sharing website, focuses on 'community and sharing.' This study investigates several online platforms related to both learning and community engagement. It investigates not only online Maker communities, but includes online learning websites, in a general sense. By looking at different online platforms, whether for Maker communities or not, this investigation gathers information about the system of tools, functions, and features available to each community. The following synopsis of precedents (see Table 1) provides a snapshot of existing models that informed the overall prototype investigations in this study.

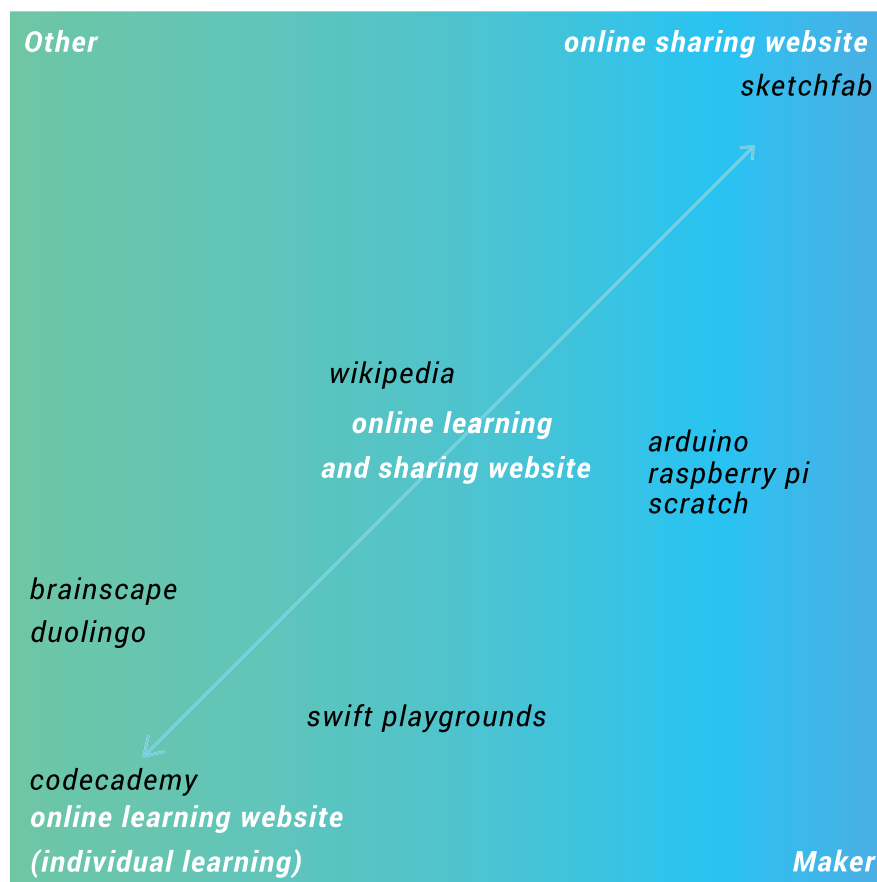


Figure 7: existing precedents ranged from 'individual learning' platforms to 'community learning' platforms.

SCRATCH



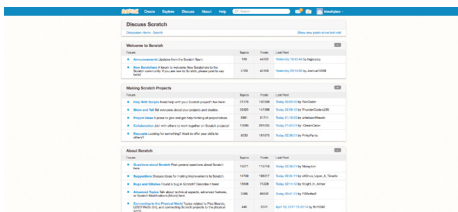
Scratch is a programming language and online community where users can create interactive stories, games, and animations.

Scratch helps young people learn to think creatively, reason systematically, and work collaboratively.



Screenshots of project and remix pages

Scratch has a feature that encourages user participation called remixing. Remixing allows users to build a project on existing, previously uploaded projects. As users remix another user's project, they contribute to a repository of shared information. This activity encourages members to make connections with other community members. It also incorporates like and comment features to help members connect with each other.



Screenshot of Scratch forum

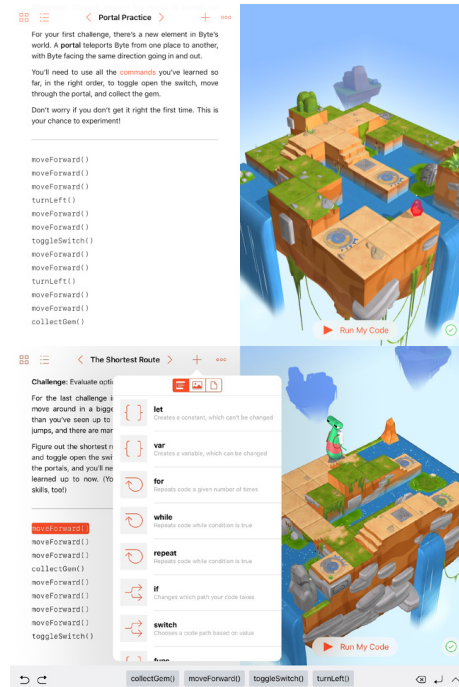
Scratch also provides a space for communication, the forum. The forum has a specific section that allows people to ask for help when members have problems with the making process.

SWIFT PLAYGROUND



Swift Playgrounds is an iPad application for learning Apple's programming language, 'Swift'.

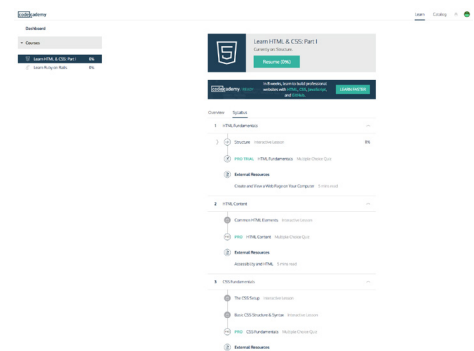
Swift Playground helps beginners learn the basics of Swift and makes learning Swift interactive and fun.



Screenshots of Swift Playground interface

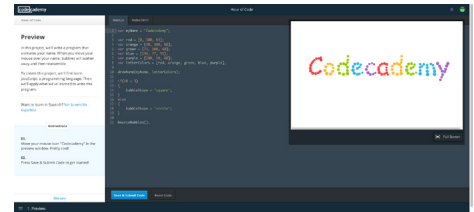
The Swift Playgrounds interface is divided into 3 parts: instruction, space for input (coding), and results. When the user sees instruction, suggestions for Swift commands appear below the input space. Suggestions correspond to the task at that moment. There is also an option for quick input, which explains the terms of that command. After the user inputs the codes and runs the program, the result is animated through a character, which the user needs to help complete the task. Swift Playgrounds includes an element of gamification through the character and task.

CODECADEMY



Codecademy is an online interactive platform that offers free coding classes in different programming languages.

Codecademy provides free resources for beginners (typically adults who want to learn new skills in various programming languages).



Screenshot of Codecademy interface when learning

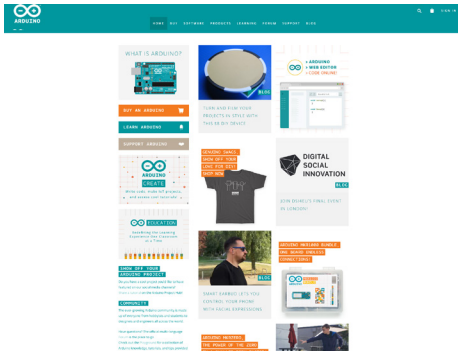
When entering a lesson, the user sees an interface where instruction is presented. The interface also provides hints as the user needs them. The right side of the interface is where the user inputs the codes and sees the result.



Screenshot of Codecademy forum

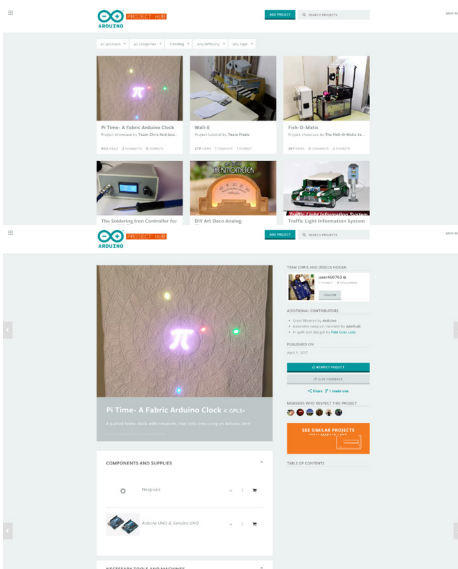
Codecademy has a separate forum where users can ask questions and receive help from the community. The Codecademy forum also provides a section for Frequently Asked Questions as a repository.

ARDUINO



Arduino is an open source, computer hardware and software company, project, and user community; it designs and manufactures microcontroller kits for building digital devices and interactive objects.

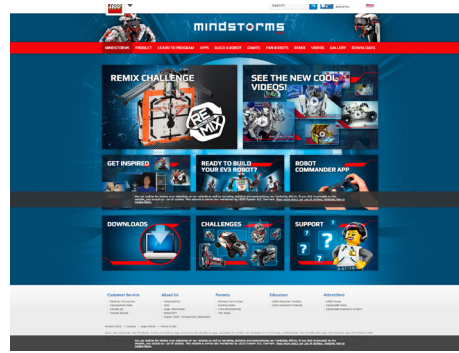
Teachers, students, designers, architects, musicians, artists, makers, programmers, and hobbyists use it to build projects and share ideas with others in the community



Screenshot of Arduino project page

Arduino has a special space, called project hub, where users upload their Arduino projects. When users click on a project to see more detail, the project hub describes what piece of the Arduino tool is used. Users have the option to indicate whether they have tried to recreate the project or not.

LEGO MINDSTORMS



Lego Mindstorms is a collection of kits and tools for creating programmable robot. Kits contain software and hardware that controls the system, a set of sensors and motors, and Lego parts to create the mechanical systems.

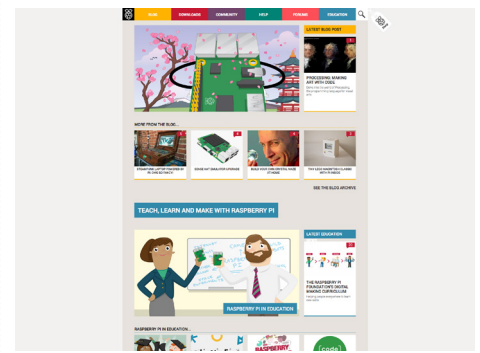
Lego Mindstorms assists learning and teaching as an educational tool, mainly for young people. However, the community comprises professionals and hobbyists of all ages.



Screenshot of Arduino project page

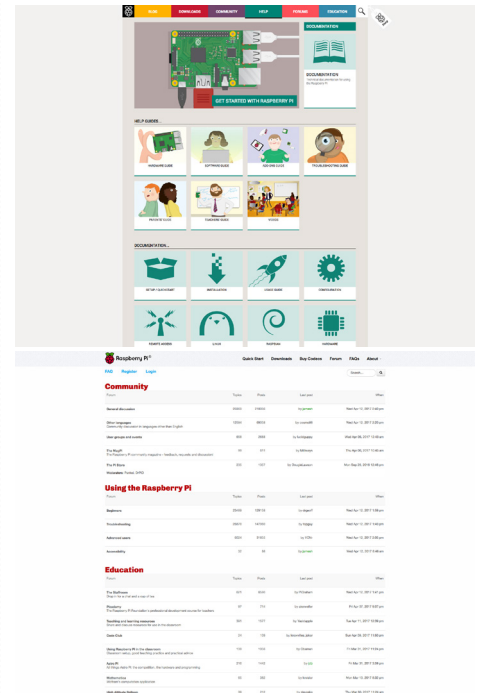
The Lego Mindstorms website is more commercialized compared to other sites in this Table. It includes a remix challenge that features Lego products. The remix challenge provides instruction on how to combine parts from different Lego sets to build a remix result.

RASPBERRY PI



Raspberry Pi is a small computer, used in different projects including software development for spreadsheets, word processing, browsing the internet, and playing games.

Raspberry Pi provides a low-cost, high-performance computer that people can use to learn, tinker, solve problems and make. It first aims to promote teaching computer programming in schools and in developing countries. However, many professionals and hobbyists of all ages use it to build projects.



Screenshot of Raspberry Pi help page

Raspberry Pi has good resources for people who want to start learning how to program or build their own computer. Guides for novices are clear. The website provides information about tools and the steps that novices need to know to get started. The guides include images (sometimes animated images) and explanations that are easy to follow.

Table 1: Existing online learning platforms investigated for this study.

INVESTIGATION

MINI STUDIES

Online Makerspace sites are becoming more open to the public to contribute content (via 'Web 2.0' tools), rather than simply display or distribute information, as in the older 'Web 1.0' paradigm (Gauntlett, 2011). The intention of Web 2.0 is to collect information from the network of people or users. Thus, the more people use and contribute, the better, because the website gains more value from the provided information or content. The implication is that crowdsourcing information is a crucial feature of the current technology.

The following 'mini-studies' focused on different aspects of a community website and its components, including current conventions. Investigations explored combinations of tools, functions, and features in order to identify design opportunities where the tools, functions, and features could be reflective of the users' current moments. The next step was to envision a system for each novice level. Thereafter, the study focused more on the tools, functions, and features, while exploring ways to incorporate community elements and strategies that help novices participate in an online community.

MINI STUDY 1: EXISTING TOOLS AND COMMON FUNCTIONS AND FEATURES

OBJECTIVE

For this mini-study, I was interested in investigating common functions and features from existing online platforms, specifically online Makerspace websites. Common functions and features informed how I structure the current information (see Tables 2– 5).

REFLECTION

Online community websites often followed a convention of information structure. The structure included the introduction or overview of the content, the space for information that moderators curated, a support system, and the user. This structure allowed users to navigate the website. To conclude, all websites that I investigated had the same basic structure. The features that I found interesting and with potential to be helpful for various novice levels included: highlight, archival, level, gradient, timeline, dictionary, annotation, search, and connection (see Figures 8.1-8.8). These features could be investigated further to determine which elements are adaptable for users.

PROCESSING

<i>Navigation</i>	<i>Tools, Functions, and Features</i>	<i>Use</i>
<i>Introduction or overview of the content</i>	Video introduction, download processing, browse tutorial, visit the reference, book, exhibition	Provided information or a portal to the information that answers basic questions, such as what the overall content concerns.
<i>Content curated by moderators</i>	Navigate to – download, exhibition, reference, libraries, tools, environment, tutorial, examples, books, handbook, overview, people, shop	Moderators generated the information and navigation to the detailed content, such as references, exhibition, tutorials, and more.
<i>Support system</i>	Forum with features: <ul style="list-style-type: none"> - popular tags, categories, announcement - announcement, common questions (using processing, programming question, question about code) - how to, hello processing, question about video tutorial - technical questions such as those about GLSL/shader, OpenGL, libraries, hardware, Kinect, Arduino, raspberry pi, modes (android, JS, python), and about tools - specific threads for other languages - specific threads for writing questions to developers – developing processing, p5.js 	The forum was the main support system for providing feedback. The forum included many threads specified to the different contents of questions, help, or interaction.
<i>User and network</i>	User – name, avatar, best answer, tag, rank Network – GitHub, issues, wiki, FAQ, twitter, Facebook	Each user had his or her unique name and avatar.

Table 2: Lists of tools, functions, and features presented on the Processing website, categorized into groups based on use.

SKETCHFAB

<i>Navigation</i>	<i>Tools, Functions, and Features</i>	<i>Use</i>
<i>Introduction or overview of the content</i>	Intro/overview — discover (included staff pick, popular, animated, and VR) Collection of projects — explore by categories, highlight (popular, staff pick, animations, VR, downloadable), collection (curated collection by moderators)	Introduces users (potential members) to the community by appealing to current content posted by the community Collection of projects allows users to browse other's work, which the creator can share and make downloadable. When users view a project, they can leave messages, like the project, or follow the creator for updates.
<i>Content curated by moderators</i>	blog — news, tutorial	Moderator curates blog posts, mostly tutorials and news/updates.
<i>Support system</i>	Forum — sort by category, latest, top post — replies, views, activity (from first post to last post in that post), category, tag, likes, links, timeline, share link	The forum was simple, but it informed users of new posts by highlighting unread posts. A color-coding system for post categories provided users with visual cues.
<i>User and network</i>	user (pro or general) — avatar, name, stats, view, likes, triangles, vertices, summary, model, collection, likes, following, followers, skill	Data collected for each user included projects complexity (such as vertices and triangles). The user feature included conventions such as 'follow' and 'like' to build connections between users. Only users who contribute to posts can display their avatars.

Table 3: Lists of tools, functions, and features presented on the Sketchfab website, categorized into groups based on use.

ARDUINO

<i>Navigation</i>	<i>Tools, Functions, and Features</i>	<i>Use</i>
<i>Introduction or overview of the content</i>	intro/overview — "what is Arduino?," blog, buy, learn, support Arduino, Arduino create (web editor, project hub, tutorial platform)	Answering basic questions for newcomers. Providing a portal to where newcomers can find more information.
<i>Content curated by moderators</i>	Navigate to — home, buy, software, products Products — each product has the overview information, technical spec, related items, documentation, and getting started Learning — getting started, welcome, install instruction, board instruction, tutorial (built in example, example from libraries, tutorial on project hub, foundation and more, hacking), reference, education, playground	Arduino provides curated content such as suggestions for products that suite user needs. The website divided products into levels: entry level, enhanced features, internet of things, and wearable. Levels color-coded by type of product; e.g. board, module, shield, kits, accessories, and coming next.
<i>Support system</i>	Forum — using Arduino, topics, development, community, make fair, products, Arduino certified products, international, general category, forum 2005-2010 (read only), forum stats, users online support — blog, social media	Forum was a portal to connect to the community. Allows members to ask questions, request help, and communicate with other members; it also archives this information, which then serves as a reference to historical content.
<i>User and network</i>	user — name, rank (newbie, jr. member, full member, Edison member, Faraday member, Tesla member, Brattain member), numbers of post, signature, avatar	Just like other platforms, the data/information stored as part of the user's identity includes rank and basic information such as number of posts.

Table 4: exhausted lists of tools, functions, and features presented on the Arduino website, which then were categorized into groups based on their uses.

LEGO MINDSTORMS

<i>Navigation</i>	<i>Tools, Functions, and Features</i>	<i>Use</i>
<i>Introduction or overview of the content</i>	intro/overview — remix challenge, see the new cool videos, get inspired, “ready to build your ev3 robot?” robot commander app, downloads, challenge, support	Introduce newcomers to the activity of the community. Did not have obvious information about what the content included. The reason might be because when the user purchases the Lego Mindstorms kit, the kit could already explain what the content is about.
<i>Content curated by moderators</i>	Main features — learn to program (introductory videos of how-to), videos (pranks, fan videos, meet the robots, inspirations, tutorials), gallery (share, see all, each robot display has like, comment, pictures, description, tag, competition, skill level, robot type, directions)	Moderators curated the information and featured content from users.
<i>Support system</i>	support — message board very generic type of forum — convention of forum FAQs, all robots forum intro: chat topic guidelines, general topics, forum stat, user online, customer service, downloads, Bluetooth support	The forum was a place for questions or general conversation. The forum did not categories posts.
<i>User and network</i>	user — person — name, Lego avatar, rank, signature, date last visit, post, like, reply, report	As with other websites, user information about name, rank, etc., however, all users had to use a Lego character as their avatar.

Table 5: Lists of tools, functions, and features presented on the Lego Mindstorms website, categorized into groups based on use.

The tools, functions, and features I examined from different online creative communities informed the following visual studies of possible tools, features, and functions that could be helpful for supporting novices (see Figures 6.1–6.8).

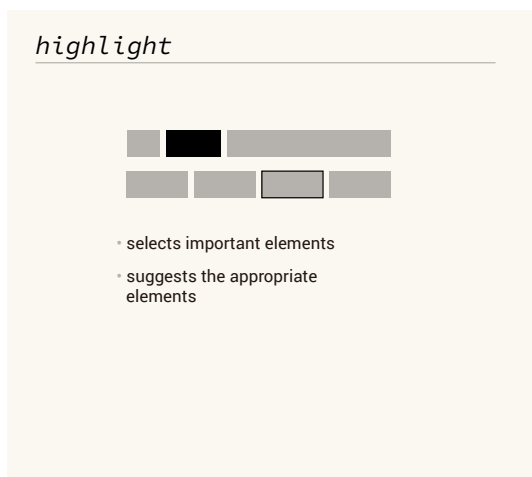


Figure 8.1: The highlight feature suggested the importance of the presented information. In other words, the highlight anticipated the action that related to the current elements or information.

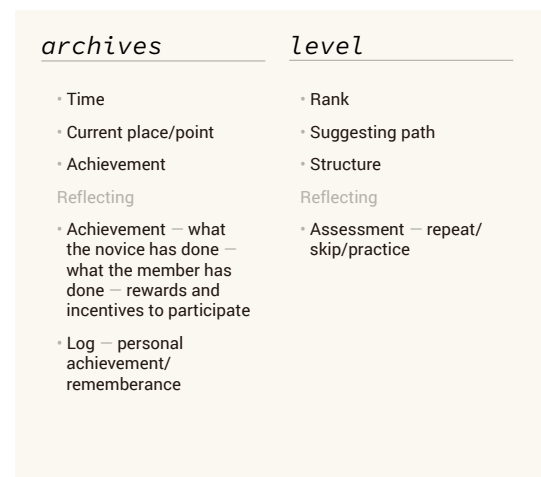


Figure 8.2: The archival feature gathered information such as the amount of time the user spent on the website, the achievement or activities the user completed, and where the user stopped. The archival feature then reflected this information back to the user as an activity log. The level feature considered achievement to determine the user’s rank. Then, the level reflects that information by suggesting the appropriate elements. The users could also self-assess to determine their level.

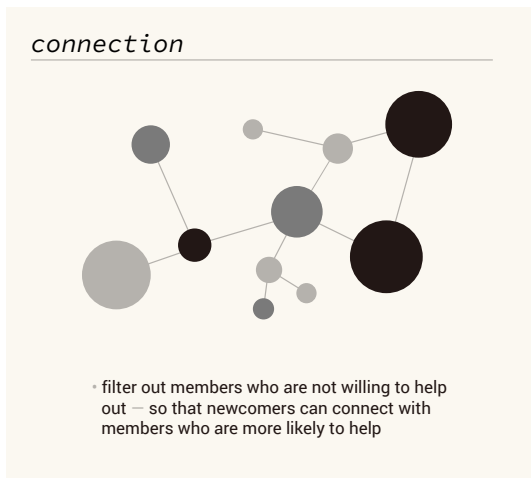


Figure 8.3: Gradients could reflect changes from one level to another, based on the user progress.

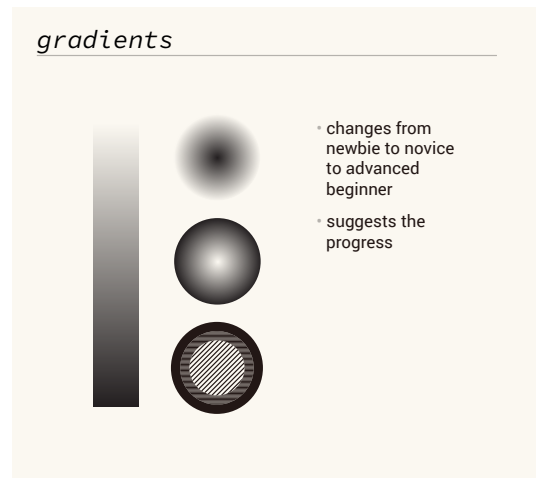


Figure 8.4: A timeline generally indicates the progress of time on video content or the progress of the user. Thus, the timeline can suggest important achievements or events. The timeline could also suggest the popularity of activities.

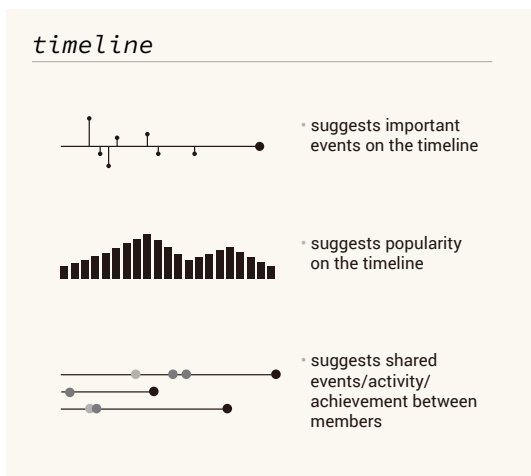


Figure 8.5: The dictionary feature could be useful for novices to learn terminology to effectively communicate with other members. In addition to providing definitions and related terms, the dictionary can suggest the terms that are more relevant to the context.

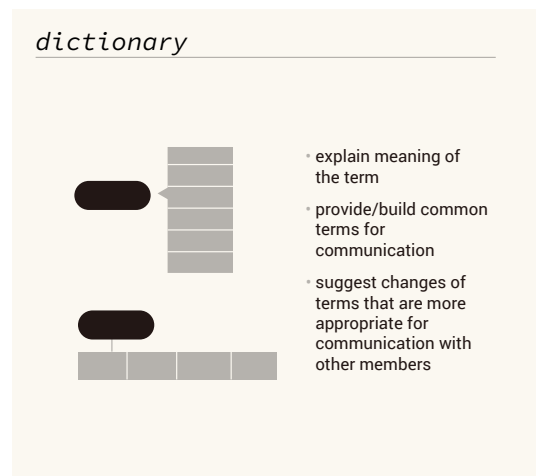


Figure 8.6: The annotation feature could indicate the importance of specific content or elements. Further, it could provide an opportunity to personalize user information, including the ability for users to add personal notes.

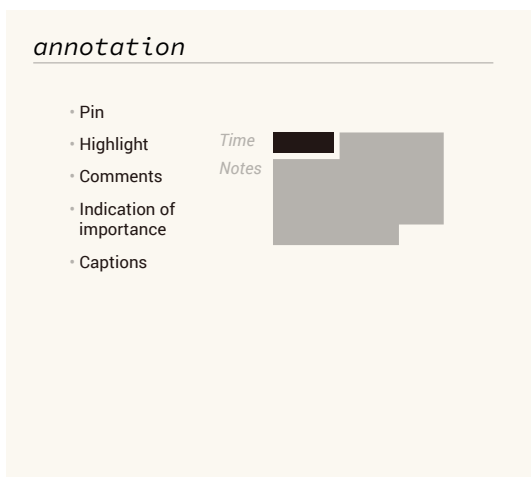


Figure 8.7: There are many ways to search for information. For instance, by keywords, tags, familiarity (this search would be related to the level feature), suggestions (also related to the level feature), relevance, and popularity.

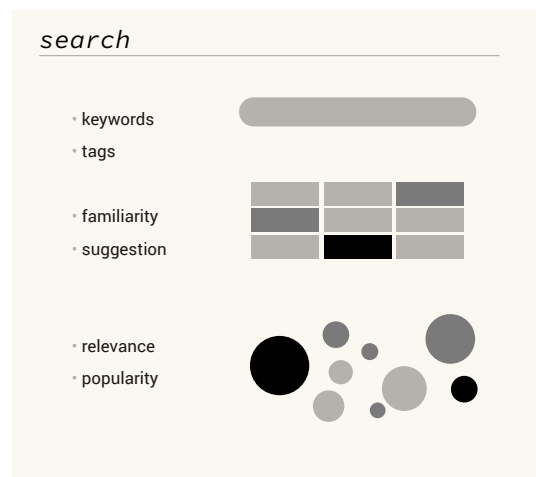


Figure 8.8: Visualizing the connections between people could indicate that a user is part of the community. The connection feature could indicate members who have more activity or influence in the community. However, it is important to think about ways to encourage novices to communicate with members who are more willingly or likely to help. These helpful members create a friendly environment for the newcomers.

MINI STUDY 2: COMBINATION OF DIFFERENT TOOLS/FUNCTIONS/FEATURES

OBJECTIVE

This study aimed to look at possibilities for helping novices learn from a combinations of tools, functions, and features based on the previous study (see mini-study 1, pg. 47). Moreover, this study aimed to identify design opportunities for creating context-sensitive tools, functions, and features. Since a contextual interface has to adapt to the user's needs, it is important to examine how context-sensitivity applies to novice levels for each tool, function, and feature.

REFLECTION

Drawing upon the findings from the previous user journey map (see Figure 6, pg. 39), novices, regardless of their level, need information and immediate help during the process of learning. Thus, the moment where the novice connects to the information or participates in the community requires investigation. This study suggested that I needed to specify 'context' or the particular moment of interaction for further investigation.

VIDEO TUTORIAL

From the previous mini-study (see mini-study 1 on pg. 47), the video tutorial and introduction were presented in many online community website. Thus, I decided to explore ways to incorporate the timeline, annotation, and dictionary features within the video tutorial.

TIMELINE + ANNOTATION



Figure 9.1: Users have an option to annotate or “pin” the video where they think it is important or when they wish to annotate by adding their personal notes.

TIMELINE + ANNOTATION (PIN) + DICTIONARY

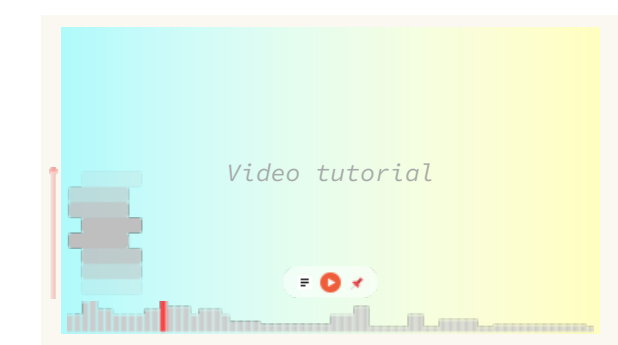


Figure 9.2: As the video mentions terms, the dictionary displays those terms in real-time. Users also have the option to pin and annotate the terms.

REFERENCES

Most of the Makerspace websites have a section dedicated to references, which is curated by the moderators. References provide more information about terms, concepts, and etc. They provide the basic information that everyone should follow in order to make.

LEVEL + GRADIENT

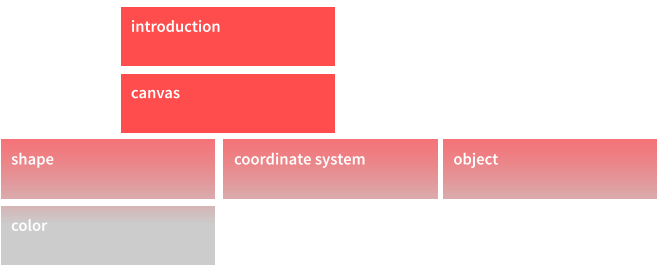


figure 9.3: combining level and gradient to show the current level and progress, as well as suggestions to what the users could explore next.

CONNECTION + LEVEL

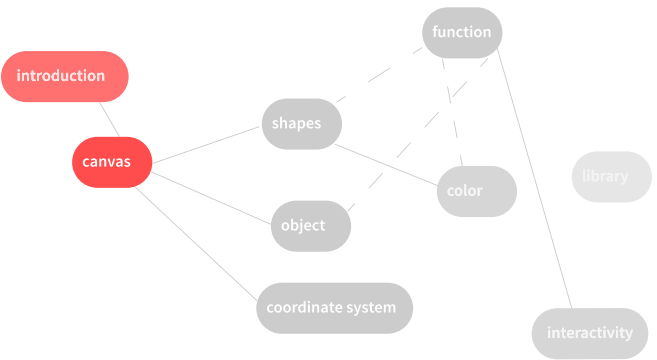


Figure 9.4: Since terms often relate to other terms, the connection feature could explain that relationship. Combined with the hierarchy of level feature, this diagram suggests the possibility of considering appropriateness of terminology with regard to the different novice levels.

HIGHLIGHT + LEVEL

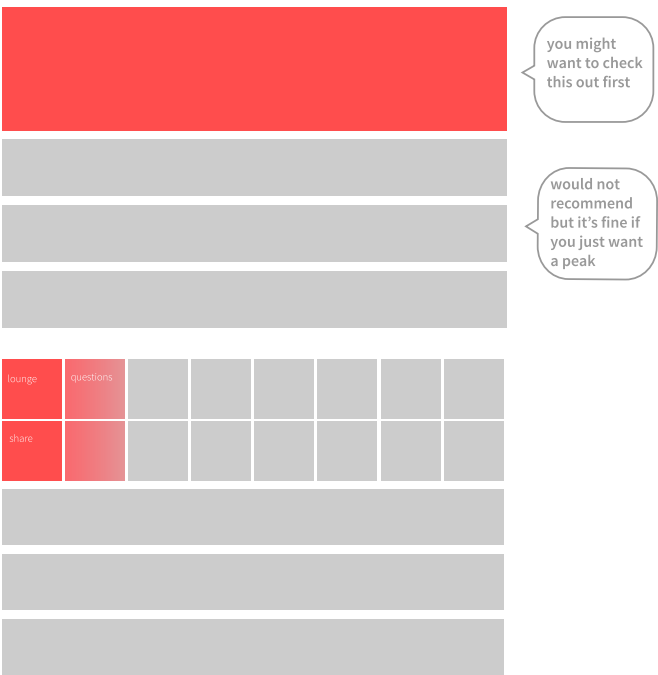


Figure 9.5: The highlight suggests place where each novice level might be more comfortable to interact or explore. The hierarchy of the level suggests the progress of the users.

CHAT

Unlike a forum, the chat function is a way for users to obtain faster replies (i.e., immediate responses) because chat tools resemble back-and-forth conversation when people are in the same space. However, in general, the chat function is linear—meaning, text is simply visualized or displayed. Thus, it is worth exploring other ways to visualize conversation information.

CONNECTION + GRADIENT + POPULARITY

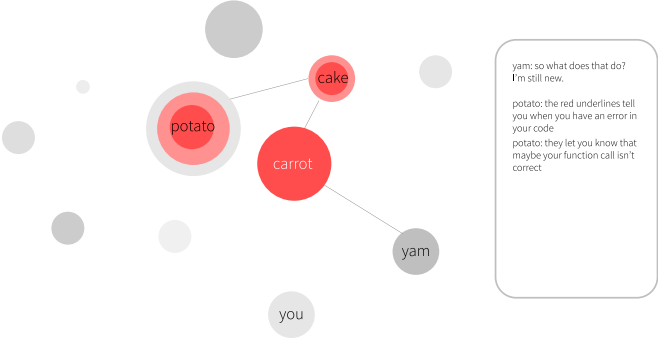


Figure 9.6: This figure suggests a new way to visualize the chat function by combining the connection feature, the gradient feature and popularity. This figure visualizes the moment when users are engaging in the chat feature. The larger the circle, the more responses an individual has replied to or engaged in during conversation. The gradient suggests the progress of that individual (i.e., the darker red the circle becomes, the more experienced is the member).

MINI STUDY 3: ENVISIONING THE SYSTEM

OBJECTIVE

This study looked at general goals for each novice level without addressing the context or user scenario. The general goals for each novice level were based on the Five-Stage Model of Adult Skill Acquisition literature (Dreyfus, 2004), which informed my Novice Gradient (see Figure 4, pg. 21). At each novice level, the goals are different because of the differences in background knowledge and experience. For instance, the newbie, who has no prior experience, needs to learn the rules that are relevant to the context (i.e., the information and its context). Whereas the novice, who possesses some experience in similar processes of making, would rather focus on gaining more experience and developing understanding of when to apply the rules (i.e., experience, rules, and implications of context). The advanced beginner, who is the most experienced type of novice, not only wants to gain more experience, he or she needs to be able to make connections to past experiences. Thus, it is important to envision a system to accommodate all novice levels.

NOVICE LEVEL AND GOALS

NEWBIE

Since the goal for the newbie is to learn rules that are relevant to the context where that information makes sense, in this system I investigate the possibilities of a 'dashboard design,' where the newbie logs into the website and sees all the possibilities that they can access. The newbie proceeds through the following steps to achieve a goal. These steps include:

- 1) Go to website
- 2) See dashboard
- 3) Look for a place to get started
- 4) See some suggested content
- 5) Explore or learn that content/information
- 6) Once the user accomplished that task (content/information), the system builds up from the activity and remembers what the user has done

Since all users prefer different ways of learning, the system could suggest choices about whether they want to learn the rules or learn from existing examples (see Figure 10.1, pg. 54).



Figure 10.1: The system shows options and suggestions based on user progress.

NOVICE

Novices have prior exposure to similar content, therefore they have some idea of what to expect and some experience and familiarity. The goals for the novice are to gain more experience by learning more, to apply the rules that they have learned from past experience to the current situation, and to develop their understanding of relevant contexts. The system would allow the novice to take the following steps:

- 1) Go to website
- 2) See dashboard
- 3) Look for a place to get started – suggested to look at existing projects or relevant elements for the project the novice wanted to do
- 4) See existing project
- 5) See keywords matching with the project the novice wanted to do

Thus, to get more experience, the novice has to cope with the ‘real situation’—in this case, learning from existing projects or other examples that community members share (see Figure 10.2).



Figure 10.2: The system suggests the novice starts with working on a project. Thus, the system asks if the novice has a project they want to make or if they want to learn from existing projects. If the novice chooses to learn from an existing project, the system suggests content that is appropriate for novices. From there, the novice can learn the concepts, terminology, or rules from those projects. However, if the novice already has a project in mind, they can choose to explore the concepts, rules, and terms by selecting keywords related to the project they want to make. From there, the system suggests related terms and concepts for the novice to explore.

ADVANCED BEGINNER

Advanced beginners, who are already experienced with similar content, would refer to their past experience and make connections to predict the situation. Moreover, the advanced beginner would need to develop a sense of what is important in that particular situation. This connection can be made by gaining more experience and guidance to achieve a goal. Thus, the advanced beginner would take the following steps to gain more experience and become engaged in the activity:

- 1) Go to website
- 2) See dashboard
- 3) Look for a place to get started
- 4) Self-assessment: skip parts that the advanced beginner already knows
- 5) Select what the user thinks is interesting
- 6) Explore that content to gain more experience

<p>What are you interested in?</p> <div> <div>generative art</div> <div>data visualization</div> <div>interactive</div> <div>games</div> <div>typography</div> </div> <p>How much do you know how to do that in Processing?</p> <div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>	<p>Concept</p> <div> <div>what is Processing?</div> <div>what is programming?</div> </div> <p>Rule</p> <div> <div>variable</div> <div></div> <div></div> </div> <div> <div>function</div> <div></div> <div></div> </div> <p>Terminology</p> <div> <div>Java</div> <div>Sketch</div> <div>Setup</div> <div>Run</div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div> <p>How well do you know this?</p> <div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div>
<p>Existing project</p> <p>Popular Project</p> <div> <div></div> <div></div> <div></div> <div></div> </div> <p>Project that you like</p> <div> <div></div> <div></div> <div></div> </div> <p>Keywords</p> <div> <div>generative art</div> <div>data visualization</div> <div>interactive</div> <div>games</div> <div>typography</div> </div>	<p>Concept</p> <div> <div>what is Processing?</div> <div>what is programming?</div> </div> <p>Rule</p> <div> <div>variable</div> <div></div> <div></div> </div> <div> <div>function</div> <div></div> <div></div> </div> <p>Terminology</p> <div> <div>Java</div> <div>Sketch</div> <div>Setup</div> <div>Run</div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div> <p>How well do you know this?</p> <div> <div>already know this</div> <div></div> <div></div> <div></div> <div></div> <div>not at all</div> </div>
<p>Existing project</p> <p>Popular Project</p> <div> <div></div> <div></div> <div></div> <div></div> </div> <p>Project that you like</p> <div> <div></div> <div></div> <div></div> </div> <p>Keywords</p> <div> <div>generative art</div> <div>data visualization</div> <div>interactive</div> <div>games</div> <div>typography</div> </div>	<p>Concept</p> <div> <div>what is Processing?</div> <div>what is programming?</div> </div> <p>Rule</p> <div> <div>variable</div> <div></div> <div></div> </div> <div> <div>function</div> <div></div> <div></div> </div> <p>Terminology</p> <div> <div>Java</div> <div>Sketch</div> <div>Setup</div> <div>Run</div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> <div></div> <div></div> <div></div> </div> <p>How well do you know this?</p> <div> <div>already know this</div> <div></div> <div></div> <div></div> <div></div> <div>not at all</div> </div>

Figure 10.3: The system provides similar 'touch points' as those displayed for the novice, but it includes self-assessment features for the advanced beginner to rate knowledge built upon past experience; they can then decide whether they want to skip that content or not. The system thereby tailors information that is more interesting to advanced beginners.

MINI STUDY 4: TOOLS/FUNCTIONS/ FEATURES AND TASKS

OBJECTIVE

The objective for this study is to explore tasks that are more likely to be performed by each novice level. After considering the tasks, I explore how the system or user interface would respond to the given task. The system or contextual interface performs responses based on some of the features from the previous mini-studies.

TASKS, NOVICE LEVELS, AND STRATEGIES

Since each novice level has different goals (see mini-study 3, pg. 53), the tasks or activities that users are likely to perform must be different. However, it is important to note that this list of tasks (chosen from the list in Table 6) cannot cover every possible activity that a novice will choose. Rather, this list of tasks includes what each novice level might do to obtain the information they need. Furthermore, it is important to note that this mini-study only explores a sample of tasks (highlighted in Table 6). The later mini-studies will address those tasks in more detail.

NEWBIE	NOVICE	ADVANCED BEGINNER
Following a tutorial	Following a tutorial	Continuing where user left off
Asking for help on forum	Finding an inspiration/ examples to make	Helping other members
Introducing oneself to the community	Sharing a project	Remixing existing project

Table 6: three tasks were chosen as an example for each novice level. The tasks in bold were the ones explored in this mini-study.

The following figures (see figure 11.1-11.6) demonstrate how the system could respond to the activities from each novice level.

TASK 1: FOLLOWING A TUTORIAL FOR NEWBIE

The tools, functions, and features presented in Figure 11.1 are video, timeline, annotation, and dictionary feature. When the newbie accesses the video tutorial section, he or she will perform the following activities: listening, processing information, memorizing important parts, and then ‘trying it out.’ Therefore, there is a need for the presentation of those features.

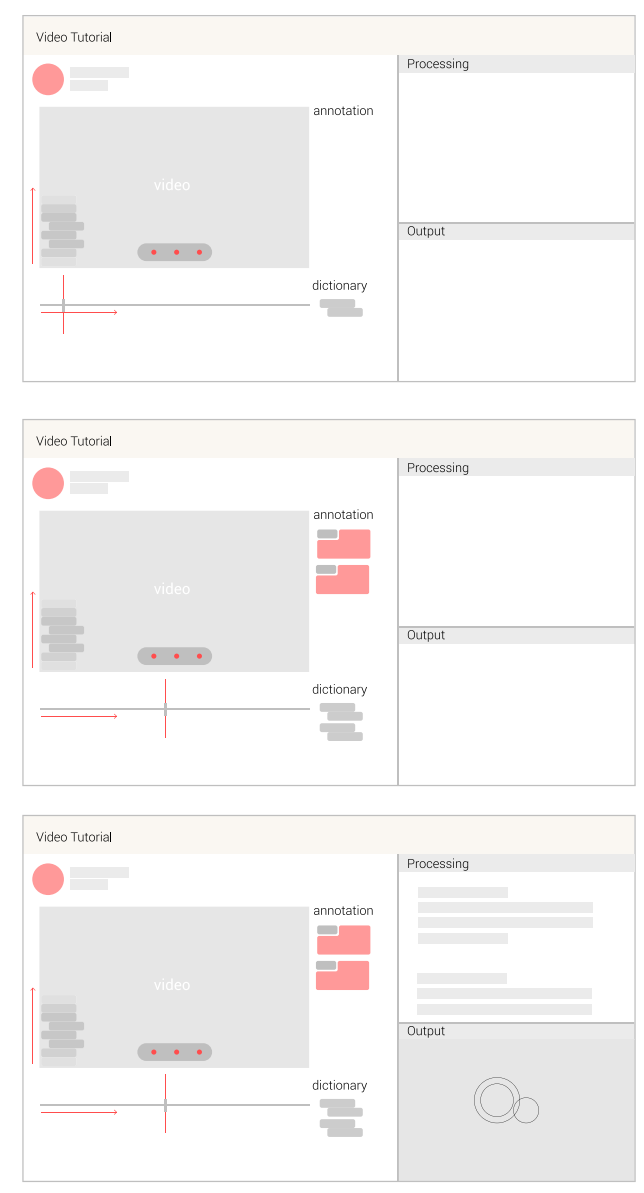


Figure 11.1: When the newbie accesses the video tutorial, the video will start playing and the terms will generate. As the newbie watches the tutorial, he or she pins the time and terms and then annotates the information at that time. When the video tutorial mentions that the newbie can try replicating the making activity (in this case, programming in Processing), the space for that task appears. The space includes a section for inputting code and the result section.

TASK 2: FINDING AN INSPIRATION/EXAMPLES TO MAKE FOR NOVICE

The tools, functions, and features presented are gradient, level, suggestion, dictionary, search, and archive. When the novice accesses the project section, he or she looks for content of interest. The interface also suggests the content that is appropriate for the novice, highlighted in blue. Different shades of blue depict how appropriate the content is for the novice. After the novice chooses the content of interest, the interface shows the related information the system has archived from the novice’s prior activity.



Figure 11.2: Novices can search for projects of interest as a way to learn or gain more information. The system suggests contents based on level if the novice toggles on the *level filter*. The novice can sort the projects by popularity, relevance to interests, and novice level.

TASK 3: ASKING FOR HELP ON FORUM FOR NEWBIE

For this task, the tools, functions, and features presented are *dictionary*, *suggestion*, and *highlight*. When newbies have questions, they can go to the forum designated specifically for the newbie level. To ask questions, the newbie creates a new post in the forum space. As the newbie types in the question or requests help, the system suggests terms that are more appropriate or relevant in this community. The suggestions of terms allow the newbie to learn about the terms and use them appropriately, which facilitates communication with other members who want to help. Communication between members in the community is important; effective communication provides incentives, such as encouragement, help, etc., for members to participate and be part of the community.

The figure shows three sequential screenshots of a forum post creation interface. Each screenshot has a title field containing 'How to make line disappear?'. The main text area contains the message: 'Hello. I have a question. When I draw a rectangle, I don't want the line. How to make the line d'. Below the text is a search bar with the suggestions 'rectangle, line, color' and a 'Submit' button.

- First screenshot:** The word 'line' is underlined in red. A suggestion box on the right shows 'Did you mean: line -> stroke'.
- Second screenshot:** The word 'disappear' is underlined in red. A suggestion box on the right shows 'Did you mean: disappear -> transparent'.
- Third screenshot:** The word 'stroke' is underlined in red. A suggestion box on the right shows 'Did you mean: disappear -> transparent'.

Figure 11.3: The system highlights the word to change for clearer communication by a red underline. The interface suggests corrections by displaying alternative words for replacement.

TASK 4: SHARING A PROJECT FOR NOVICE

The tools, functions, and features presented in this task are archives, suggestions, and ephemerality. When the novice wants to share a project (or sketch, as in this case), he or she clicks on share your sketch and the interface calls up the space where the novice can type in programs to run. After the novice is satisfied with the code, he or she enters a title and details about their sketch. Before submitting to the system, the novice can choose the privacy level in the sharing feature, as well as how long the sketch remains in the system. The reason for ephemerality is that it lowers the stress on the novice to participate in the community (participate by contribute the sketch to the community archive), because the novice knows that what they share will not be presented forever. Thus, the novice does not have to meet the expectations from other members of the community.

The figure shows three sequential screenshots of a sketch sharing interface.

- First screenshot:** A dashboard titled 'sketchbook' with a grid of project thumbnails, a 'share your sketch' button, and an 'achievement' list on the right.
- Second screenshot:** A form titled 'sketchbook' for sharing a sketch. It includes fields for title, description, tags, privacy (set to 'everyone can see & remix'), and time (set to 'until I decide to delete'). There are 'share' and 'cancel' buttons.
- Third screenshot:** The same sharing form as the second, but with a sketch of 'interactive circles' visible in the preview area on the right.

Figure 11.4: The first screen shows all the sketches that other members have shared. The second screen is where the novice enters information, such as title, detailed descriptions, the code or program, and displays the output. The novice can provide tags for other members as search terms. Lastly, the novice indicates how long he or she wants a sketch to remain public and who can see that sketch.

TASK 5: CONTINUING WHERE LEFT OFF FOR
ADVANCED BEGINNER

The main features for this task are archive, timeline, gradient, and connection. When the advanced beginner logs in to their account, this dashboard appears. The timeline shows user progress, assuming that the advanced beginner has interacted with this interface and system before. The advanced beginner has the option to start at the previous activity from where they left off. The forum panel suggests the advanced beginner read the newest posts. The system also reports a summary of progress that other members (e.g., friends) have achieved while the advanced beginner was away. The system presents the advanced beginner with information, such as terms, that he or she has previously self-assessed when active.

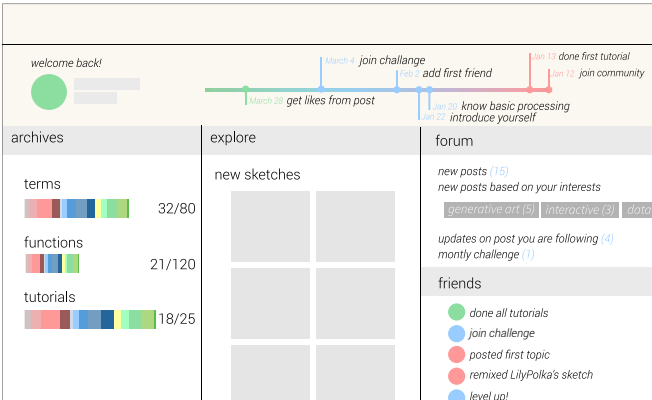


Figure 11.5: The interface reports the progress that the advanced beginner has completed during interaction with the system or the community.

TASK 6: INTRODUCING ONESELF TO THE
COMMUNITY FOR NEWBIE

The main tools, functions, and features presented in this task are connection, suggestion, and archive. When the newbie goes to the forum there is a specified section to introduce themselves to the community. The newbie will then see introductory posts from other newbies. He or she can select the introduction entry to see if which newbies have similar interests. When the newbie decides to make an introduction, there is an opportunity to introduce a strategy feature that helps the newbie in entering the community. For example, the system prompts the newbie with a short piece of program they can easily modify and be proud of the accomplishment. However, this study did not explore this particular feature; further studies may acknowledge this opportunity.

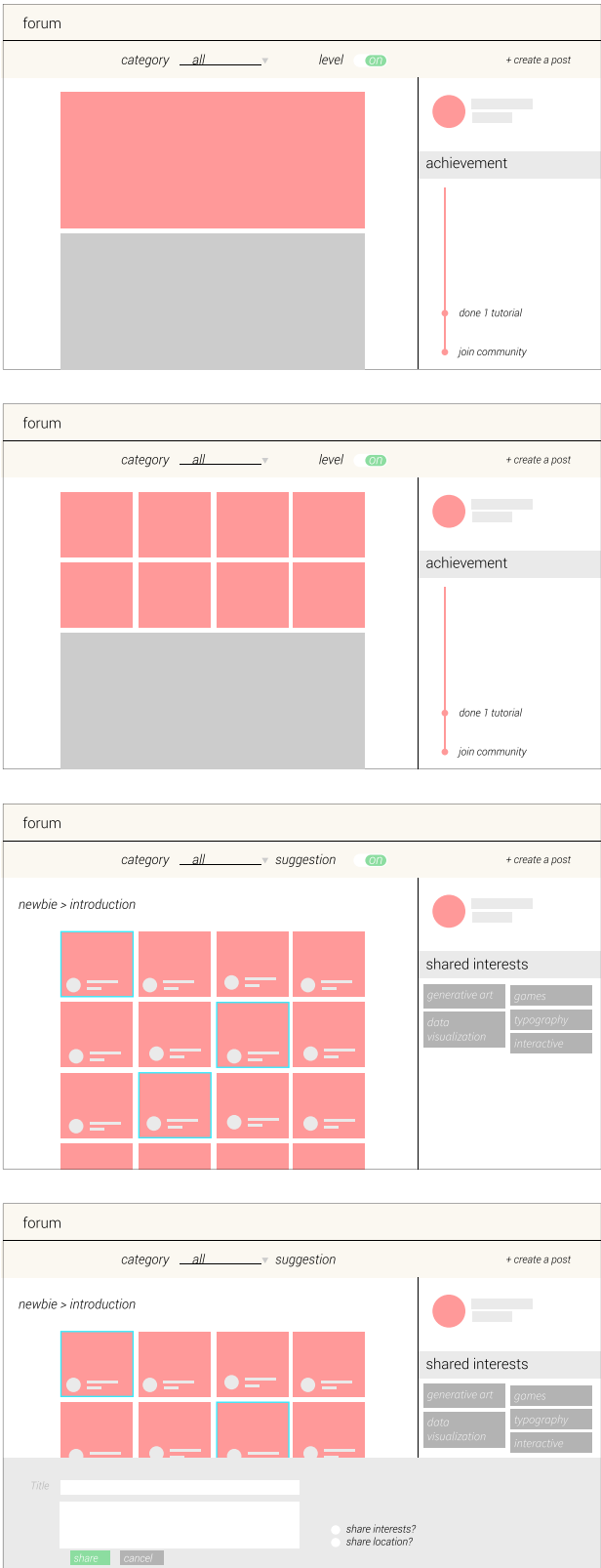
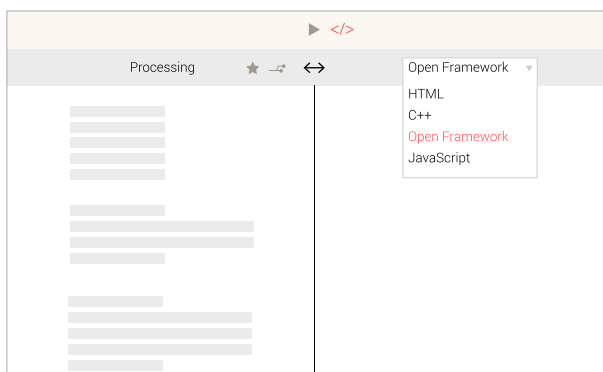
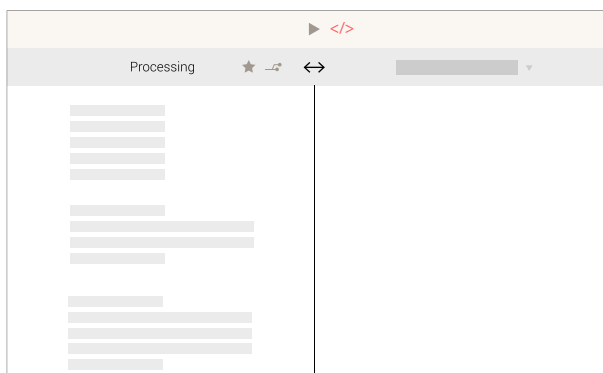
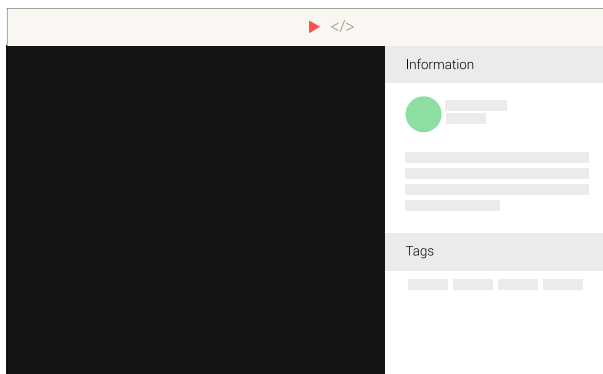
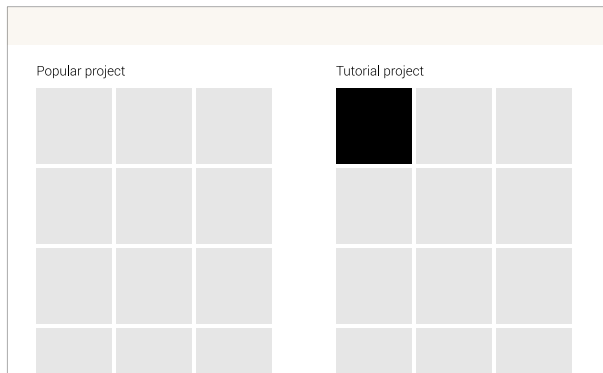


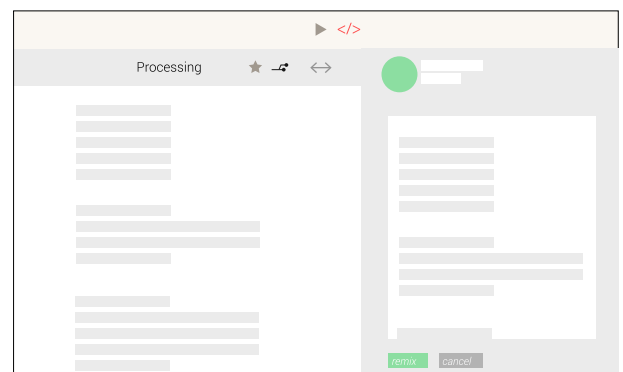
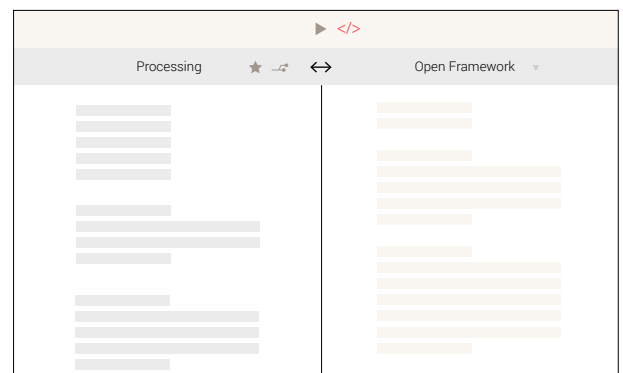
Figure 11.6: The system includes a specific space and section on the forum for newbies to make introductions. Newbies can indicate whether they want to share information, such as their locations and interests to the rest of the community. Once a newbie shares the introduction entry, the system records that information and saves it the archive.

TASK 7: REMIXING A PROJECT FOR ADVANCED BEGINNER

Figure 11.7: The system provides information about the chosen project. The system includes the translation panel for the advanced beginner to explore. When the advanced beginner types in the remixed code, he or she can choose to translate the remixed version into a programming language with which they are more familiar.



The main tools, functions, and features for this task are archive and suggestions. When the advanced beginner logs in to the system and looks for a project to remix or recreate, the system/interface shows archives of projects posted by community members. After the advanced beginner chooses the project that he/she is interested in, the system provides information, such as person who shares it, description about the project, and relevant terms tagged by the creator, about that project. Then, the advanced beginner has access to the source code or information of that project. The system provides an option for the advanced beginner to see the translation of the source code in a programming language with which the advanced beginner is more familiar, which is generated by other community members. When the advanced beginner understands the project and wants to remix it, he or she clicks on the remix button, and when the project is completed, has the option to submit their remixed version. There is also an option to submit the new translation.



MINI STUDY 5: COMMUNITY ELEMENTS

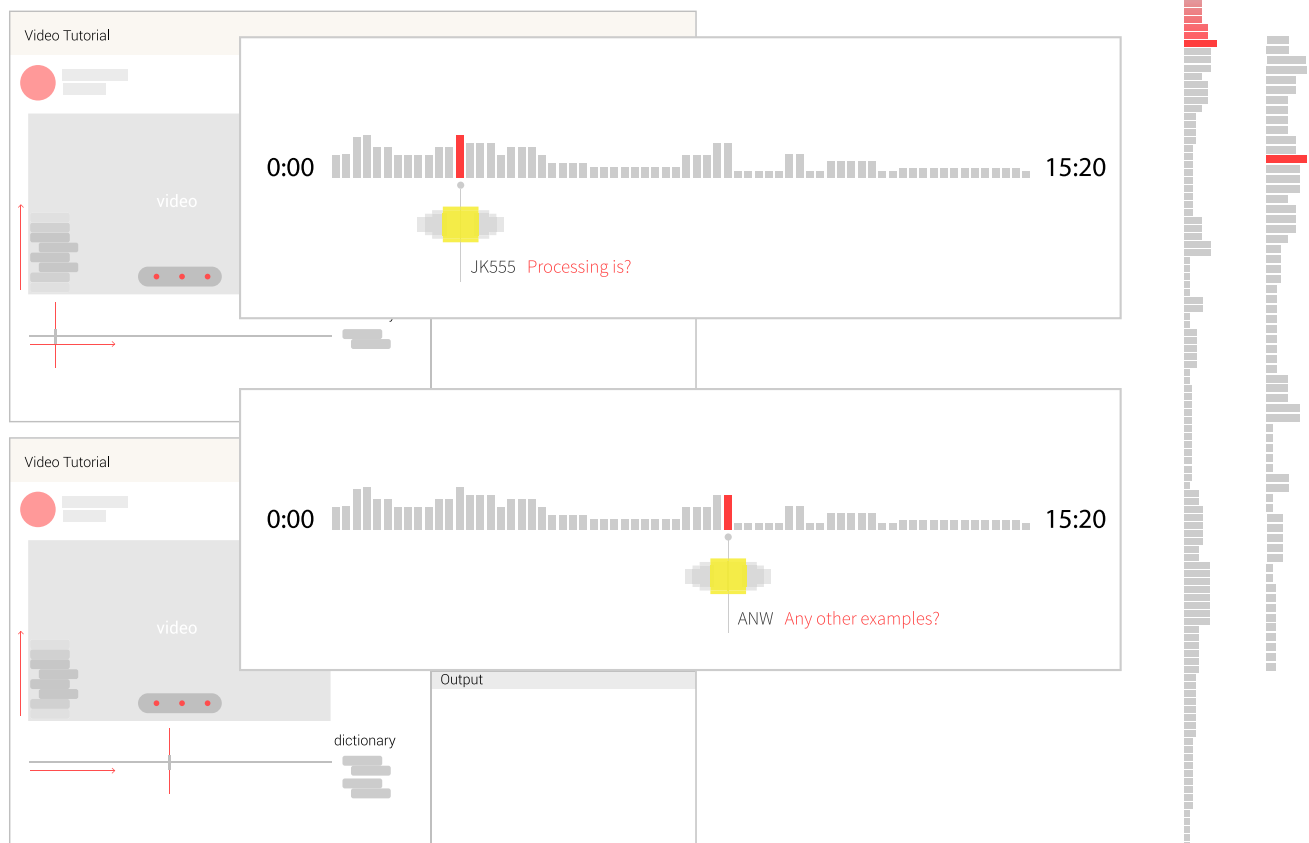
OBJECTIVE

This mini study aimed to identify some opportunity to incorporate community elements such as member-generated information to the interface. The task for this mini study was based on the previous studies.

VIDEO TUTORIAL AND MEMBER-GENERATED INFORMATION

While the newbies, novices, and advanced beginners watch the video tutorial—which seems like a personal task—the system introduces the presence of other members by incorporating member-generated information. This study explored how many times other members pin important information or indicate help and questions. This information could be visualized in terms of the height of the timeline's curve. Thus, when newbies, novices, and advanced beginners see those spikes approaching in the playback controller, they know there is activity that other members have generated.

Figure 12: various iterations of visualizing timeline and member-generated information



CASE STUDIES: PROCESSING

To frame this research in a practical world, this investigation is based on the current content from the Processing.org website (<https://www.processing.org/>). To complete the prototypes that follow, I explored the website's content and chose pertinent learning activities that were appropriate for each novice level.

PROCESSING

Language and software
<https://www.processing.org/>

Processing is a language built on Java, as well as software for learning to program within the context of the visual arts (Figure 13.1). Processing has a large community of artists and programmers, and allows non-programmers to learn computer programming aided by visual feedback.

PROCESSING (WEBSITE) TOOLS/FUNCTIONS/FEATURES

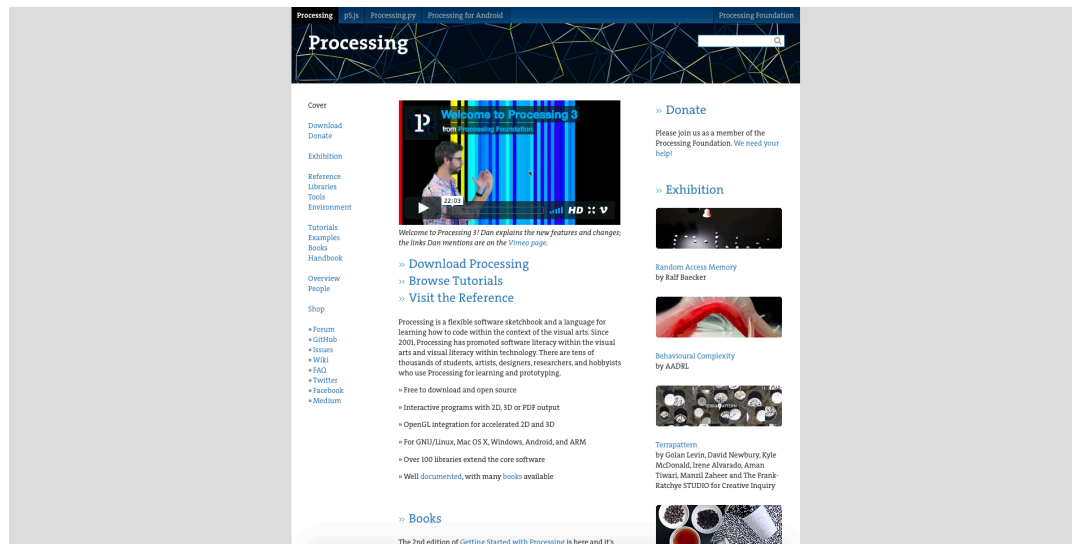


Figure 13.1: Screenshot of Processing website

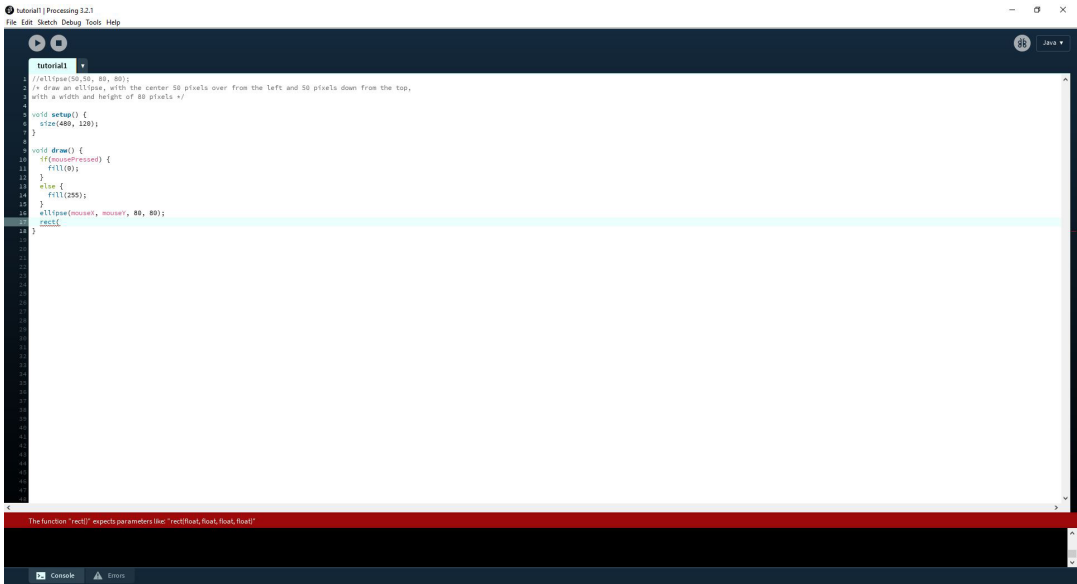
The Processing website has vast resources of information. It also includes functions and features that are context-sensitive. For instance, during the video tutorial, the video screen shrinks and the space for typing in code and showing results appears (refer to Table 7).

PROCESSING WEBSITE

Structure	Tools, Functions, and Features
Introduction/ overview	Video introduction, download processing, browse tutorial, visit the reference, book, exhibition
Navigation	Navigate to – download, exhibition, reference, libraries, tools, environment, tutorial, examples, books, handbook, overview, people, shop
Support	Forum with features: <ul style="list-style-type: none">- popular tags, categories, announcement- announcement, common questions (using processing, programming question, question about code)- how to, hello processing, question about video tutorial- technical questions such as those about GLSL/shader, OpenGL, libraries, hardware, Kinect, Arduino, raspberry pi, modes (android, JS, python), and about tools- specific threads for other languages- specific threads for writing questions to developers – developing processing, p5.js
User and network	User – name, avatar, best answer, tag, rank Network – GitHub, issues, wiki, FAQ, twitter, Facebook

Table 7: Lists of tools, functions, and features presented on the Processing website, categorized into groups based on use.

Figure 13.2: Screenshot of Processing software



PROCESSING SOFTWARE

Feature	Use
Highlighter	highlight to indicate where the cursor is (can be assume that it indicates where the user left off)
Color codes	to indicate what type of information for each word – if it is a reserved word/function word/etc.
Underline	as the user type, if the syntax isn't correct, it will have the red underline (while error message indicates in the compile tab) the error message will provide the rules for the correct format of the syntax

Table 8: This table shows the tools, functions, and features of the Processing software.

PROCESSING (IDE)
TOOLS/FUNCTIONS/FEATURES

Since Processing has two separate platforms—the website and the software—it is useful to look at the software to understand the various tools, functions, and features (Figure 13.2).

PERSONAS

NEWBIE

Ann is a graphic designer in her early thirties. Ann has a traditional training background in design. She has not done any programming before. Ann wants to start learning programming in order to add that to her toolkits. Ann is interested in exploring generative design. She does not know where to start but she has a goal of learning basic rules and concept of programming. Ann is anxious and overwhelmed with the idea of programming because she thinks it is intimidating and complicated, but she wants to understand how it works and want to be able to do a visualization that she imagines.

NOVICE

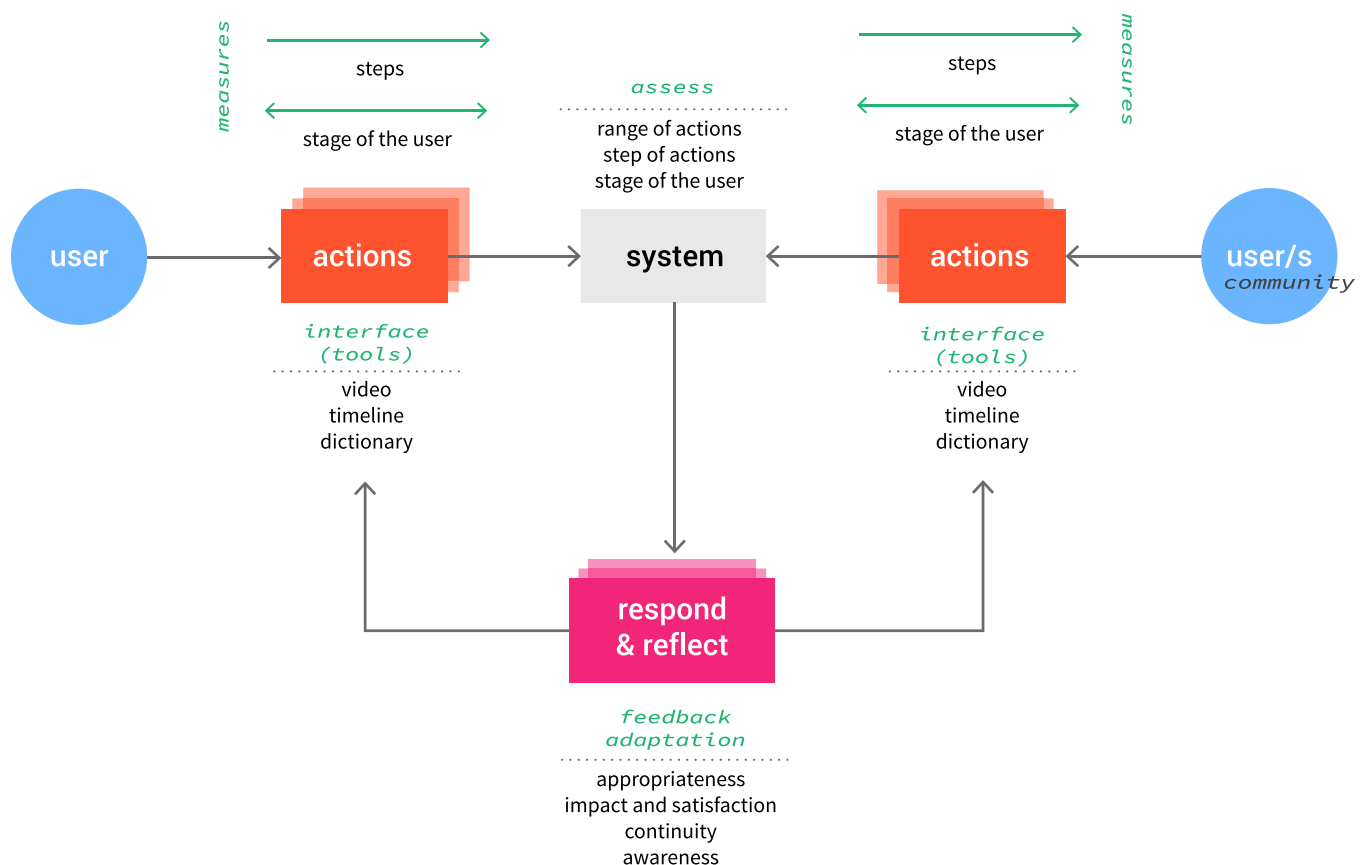
Brian is a graphic designer in his mid-twenties who has interest in information design. Brian has taken a programming course for designers where Brian learned to program with JavaScript and HTML. When Brian stumbled upon a data visualization done through Processing, Brian was intrigued and wanted to be able to do that. He tried out different programs that he was more familiar with such as Sketchup, but Brian concluded that it could not do what he wanted. Brian, then, decided to learn Processing but still was not sure if Processing would be easy enough to learn.

ADVANCED BEGINNER

Kate is a graphic designer in early-twenties who has done some web designing. Kate has tried programming before such as HTML, JavaScript, and Python. Kate has been interested in programming. She knows what to expect when learning programming. When Kate is introduced to Processing from her colleague, she becomes interested in learning more. Kate wants to make a data visualization that will be generative from data that she gathered. Kate wanted to reduce the time that she usually spends on making similar data visualization in tools such as Adobe Illustrator.

PROTOTYPE

Since the context-sensitive interface has to adapt to respond to the user's needs, the interface must take different actions and the stage of the user's knowledge in to account. The interface must consider different nuances of that action in order to perform appropriate feedback. The contextual diagram (see Figure 14) illustrates how the system responds to users while considering both the user actions and the community's actions. Since the user is interacting with the system and the other users, it is important to consider the activity from both ends.



For this investigation, the system considers the range of the actors' actions (i.e., newbie, novice, and advanced beginner) when interacting with or using the interface tools, functions, and features. After the system recognizes any given action, it measures the user's novice level and the steps that a user is performing. Then, the system provides feedback to that action based on appropriateness, the impact and the satisfaction, continuity, and awareness. The appropriateness of feedback refers to whether the system selects an appropriate adaption strategy, while the impact and satisfaction considerations expect the feedback to increase user satisfaction as they receive the feedback (Paterno). Not only does feedback expect satisfaction, it has to maintain the continuity of the users' activity (ibid). Lastly, it is

Figure 14: A diagram created in collaboration with April Maclaga. This diagram reflects the input and feedback system of the technology, which in this case is the contextual interface, specifically the video tutorial, the timeline, and the menu features.

important to consider the user's awareness of the interface adaptation. This feedback raises questions about what to extend so the user can recognize the changes in the interface caused by adaptation (ibid).

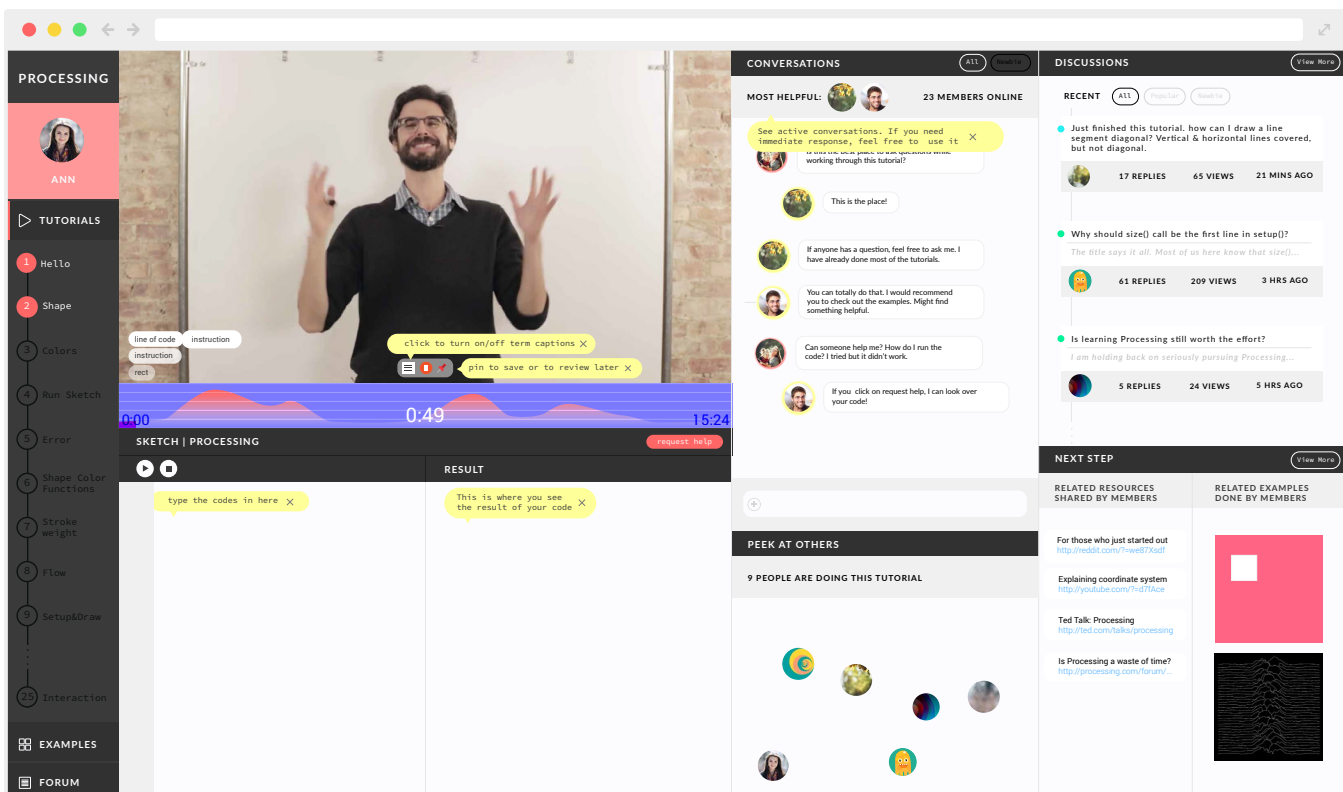
Based on the mini-studies, I realized that I was looking at the whole system rather than a specific moment. While imagining the entire system of the context-sensitive interface, I recognized that human action or activity, in general, was complex. The task or activity that I imagined as being small, which in this case is learning to make in the context of Processing, is quite complex. Thus, I wanted to focus on a small, simple moment, such as following a video tutorial, to explore how that part of the system could work. Therefore, in this final phase of the visual study, I focused on one specific moment to explore ways that the interface could respond to each level—newbie, novice, or advanced beginner. The final investigation was based on the content from the *Processing.org* website.

SCENARIO

Based on the Processing website and its existing content, the overarching scenario for all novice levels is learning to create a data visualization through Processing. Each person goes through a video tutorial to learn more. The scenario is specifically focusing on a video tutorial. Each person encounters different responses from the interface according to his or her actions and novice level.

Newbie – After Ann logs onto her account for the first time, she selects a video tutorial to learn more about Processing. While Ann is watching her first video tutorial, she notices that the interface generates terms as the video plays. She becomes curious about a term that she has not heard before, and clicks on the term to learn its meaning. When Ann glances at the timeline, she sees the peaks and lows of the curve. When she clicks on the peak of the curve, the timeline suggests how many instances past users considered that information important (Figures 15.1–15.10).

Figure 15.1: After Ann logs into her account and selects her first tutorial to watch, she sees this screen. The right side of the interface shows Ann that she has access to the community whenever she needs help. The panels include conversation (the chat panel), peek at others (to see other active people who are also doing the tutorial), discussion (show what the community is up to), and next step (which provides pointers for Ann when she is done with the tutorial or if she wants to skip).



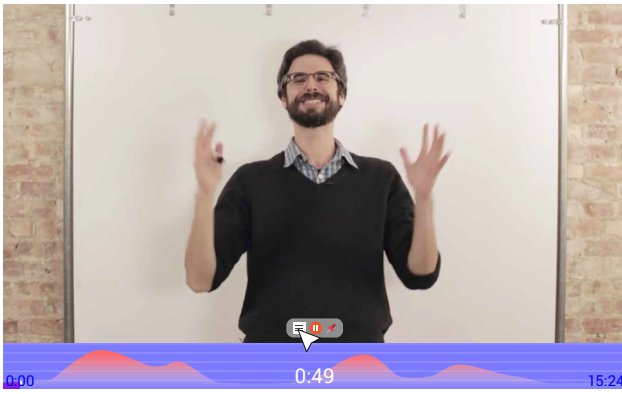


Figure 15.2: Ann clicks on the caption icon to turn on the dictionary tool.

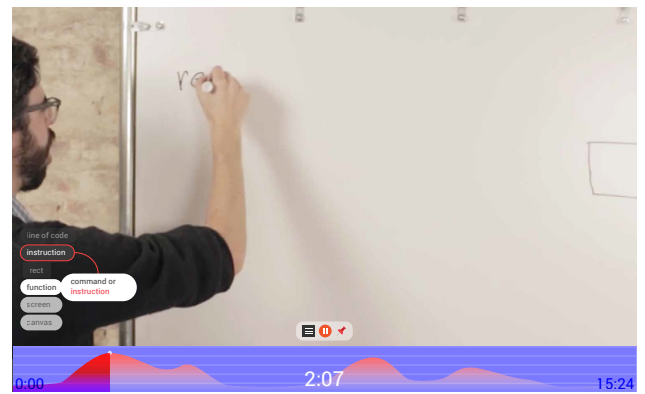


Figure 15.5: the interface also shows Ann the connection between the current term and the previous term that she has previously learned. The interface indicates the connection by a red line.

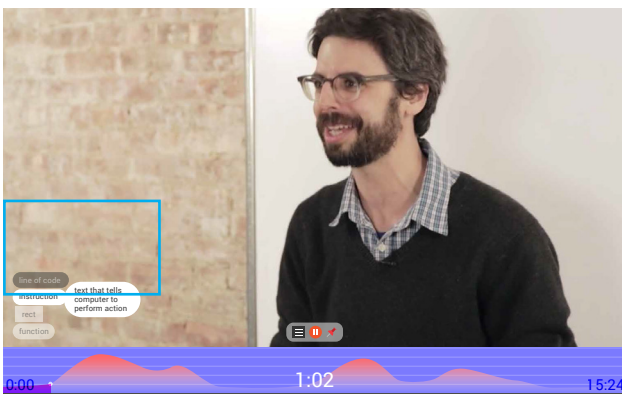


Figure 15.3: Ann sees the terms the system generates. The system generates the terms based on the content of the video. Note that the shape of the term indicates the type of term, and gives Ann visual cues to which term is consider a general concept, a function, a parameter, etc.

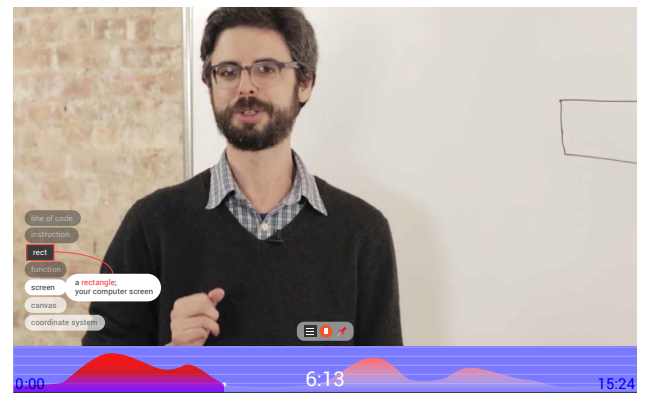


Figure 15.6: When Ann see the connection of terms, she can either click on an option and skip back to the time where that term was first mentioned if she is still unsure about the term.

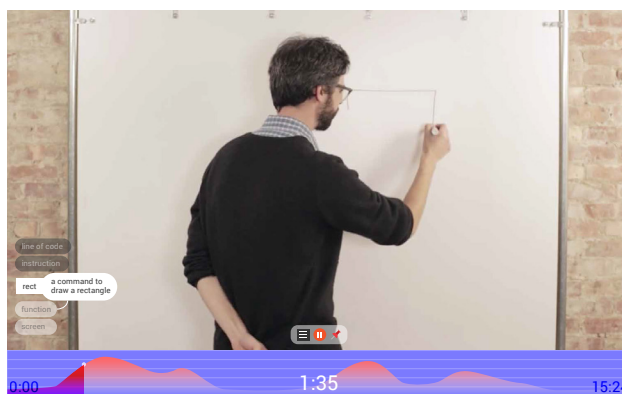


Figure 15.4: when Ann click on the term, she sees the definition of that term and a line shows a connection about her current term and anticipated term that is mentioned later in the video.

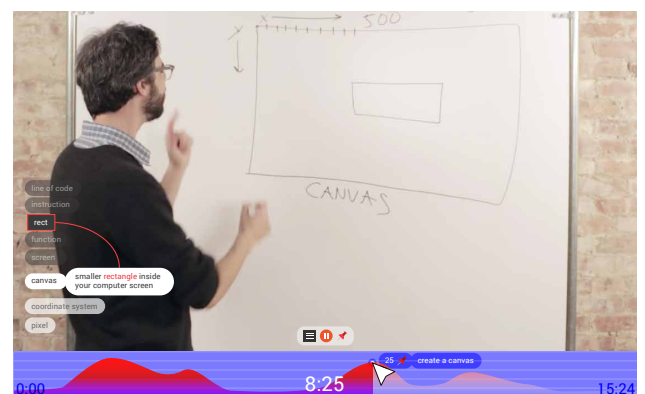


Figure 15.7: when Ann clicks on a peak of the curve in the timeline, the timeline shows information that is generated by other members who have completed the tutorial and those who are still doing the tutorial. The peaks of the curve indicate the importance of the content in real time.

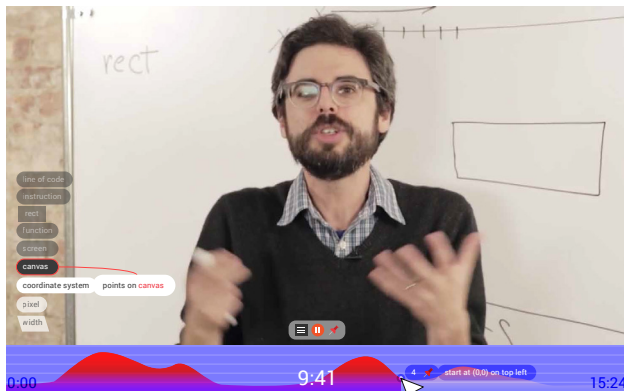


Figure 15.8: when Ann clicks on the curve in the timeline, the timeline will still respond to that action by giving her more information.

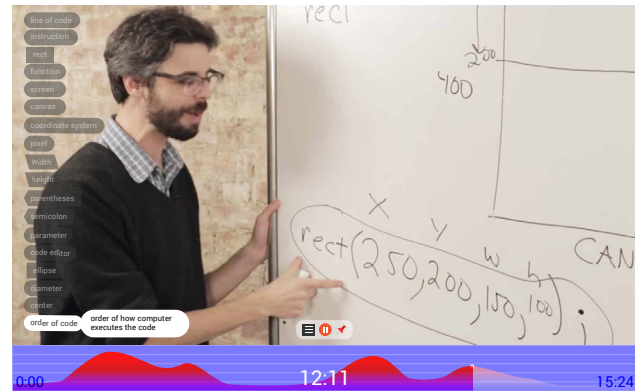


Figure 15.9: When Ann reaches the end of the video, she sees how the terms that she learned in the video build up over time.

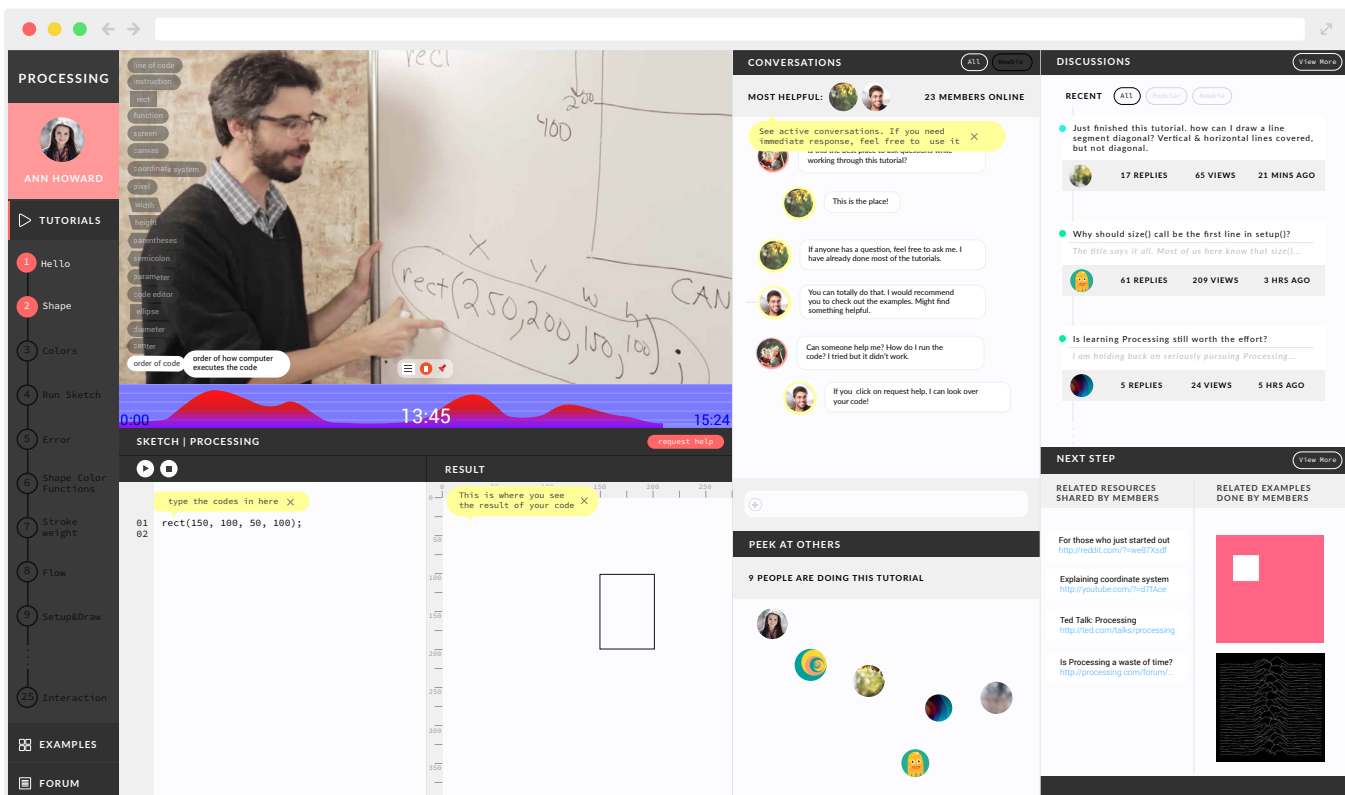


Figure 15.10: The full screen of how the content builds up over time.

Novice –Brian, who has a little background experience in programming, logs onto his account and selects the video tutorial. He sees a white bubble on the left side of the screen. When he clicks on that bubble, the system displays the terms that the system has generated. Since the system knows that Brian is a novice, it suggests a place in the video where Brian could skip forward. After he clicks that spot to fast forward the video, he sees how the terms accumulate and he can choose to hide the terms that he already knows.

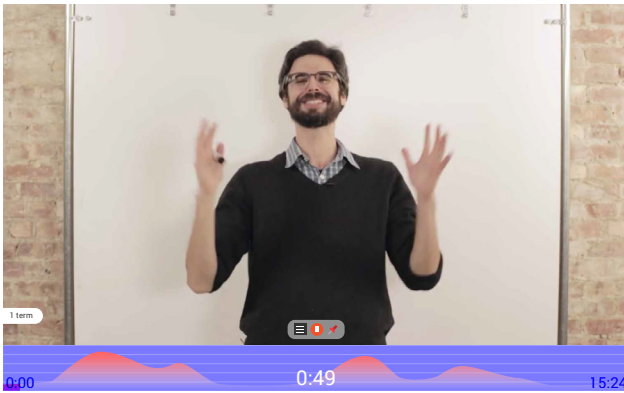


Figure 16.1: Brian sees the white bubble on the left side of the screen saying "1 term."

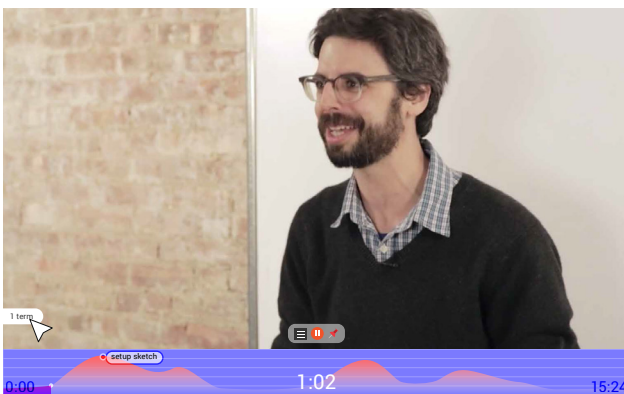


Figure 16.2: Brian becomes curious about the white bubble, and clicks on it. Brian also notices that the system suggests a spot where he can skip over sections to view material interesting that is interesting to him.

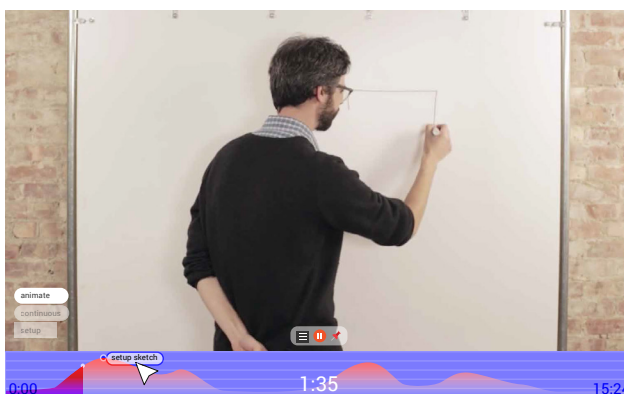


Figure 16.3: after Brian clicks on the bubble, it expands; he sees several terms that were hidden. He decides to click on the suggestion to skip over the introduction of the tutorial.

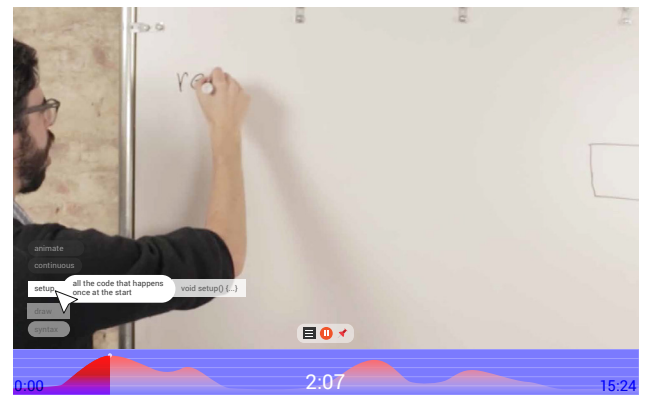


Figure 16.4: After Brian skipped over to parts of the video, he clicks on the term that he wants to explore further. The term shows the definition and a suggestion for syntax (the lower opacity bubble on the right of the definition bubble).

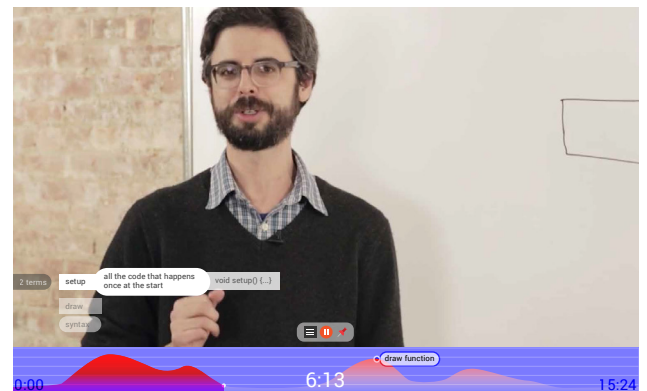


Figure 16.5: Brian selects the terms that he already knows to hide them.

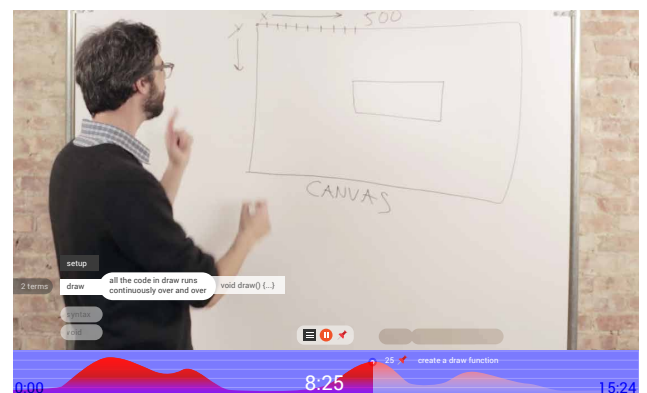


Figure 16.6: Like Ann, Brian can click on the peak of the timeline curve to see what other members commented in the tutorial at that time.

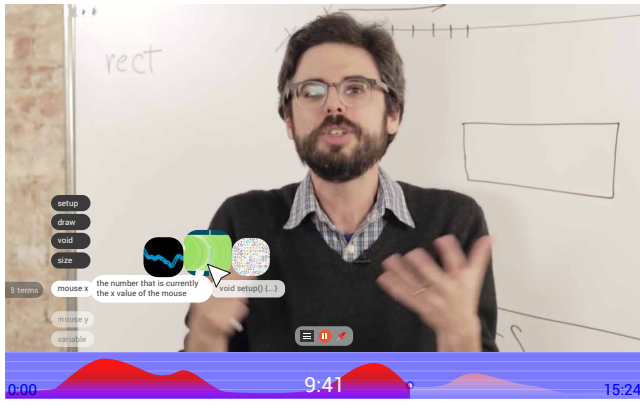


Figure 16.7: Brian can click on a term to explore more of examples that use this term in the code. He then selects an example

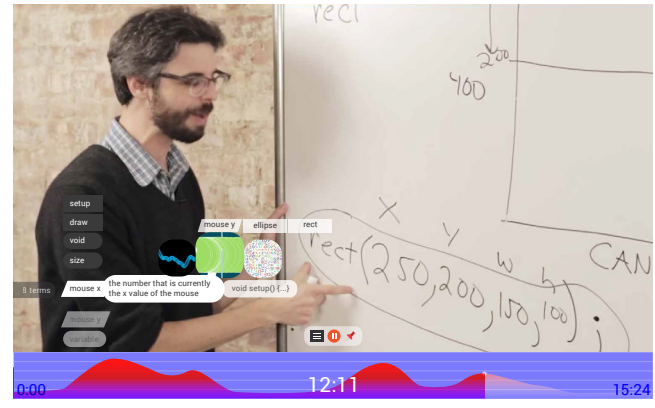


Figure 16.8: The system shows more terms related to, or used in, that example so Brian can better understand what the project is about, and decide if he wants to complete that project, or if he knows all the terms he needs to complete it.

Advanced beginner – Kate has more experience in programming, since she has programmed in other languages prior to completing this tutorial. When she opens the Processing website and logs onto her account, Kate decides that she will search the tutorials to see if there is anything interesting.

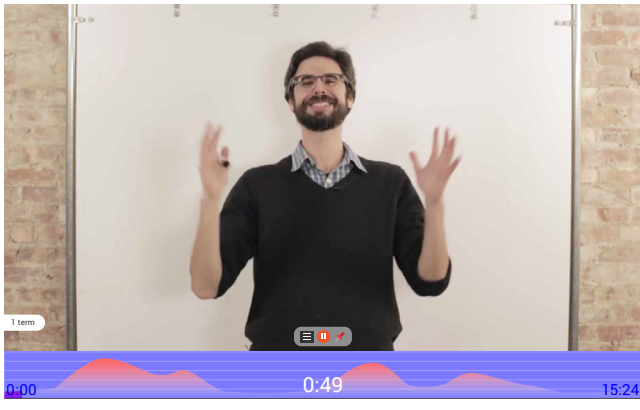


Figure 17.1: As with Brian, the interface hides the term that Kate does not need to see.

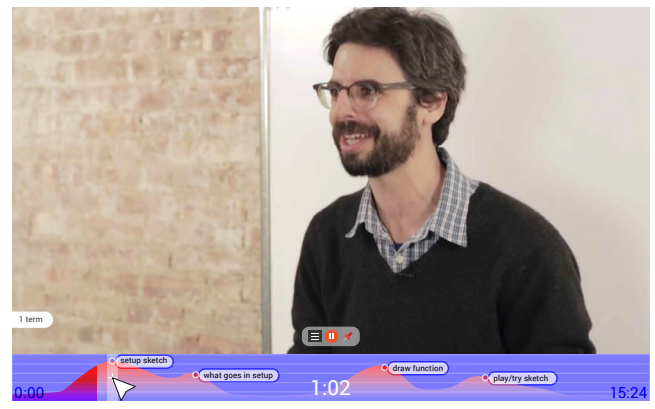


Figure 17.3: Kate clicks on the plus sign.

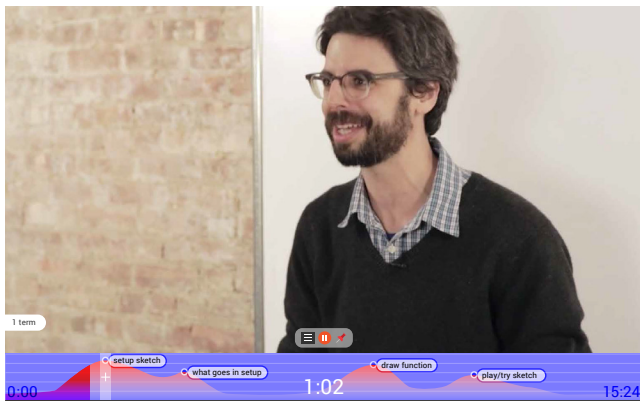


Figure 17.2: As the video tutorial plays, the system suggests points of interest where Kate can skip forward. Kate also notices a plus sign.

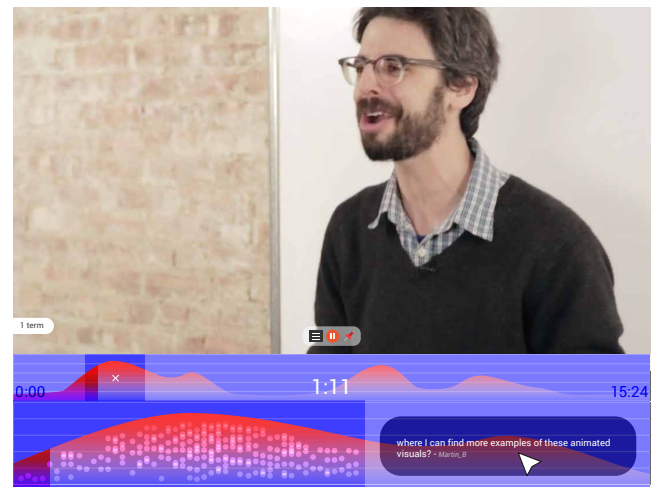


Figure 17.4: The system zooms into the timeline visualization, where Kate can see all the instances where other members have inserted pins, as well as where they had asked for help or other questions.

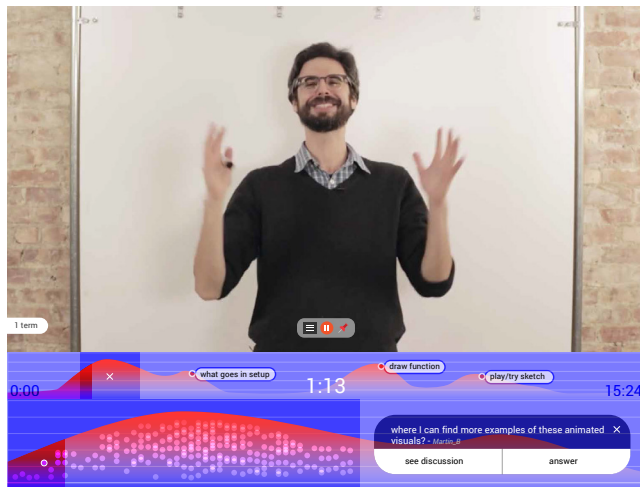


Figure 17.5: Kate wants to know more about a question and its answers. She clicks on the circle representing the instance to see what actions she can access.

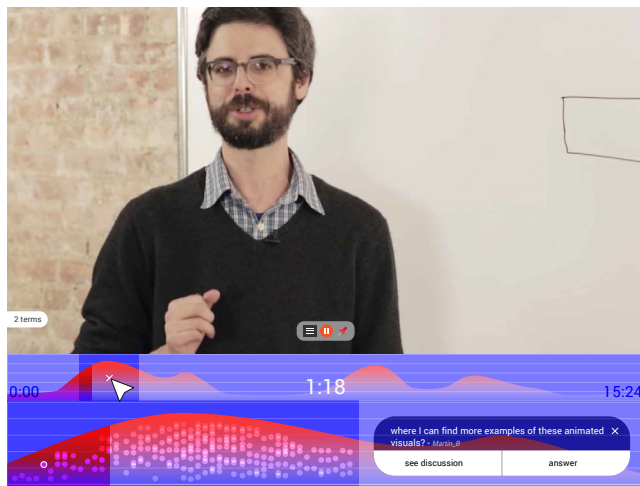


Figure 17.6: Kate can choose to either explore the discussion on her chosen question, answer that question, or resume the video. Kate decides to resume the video.

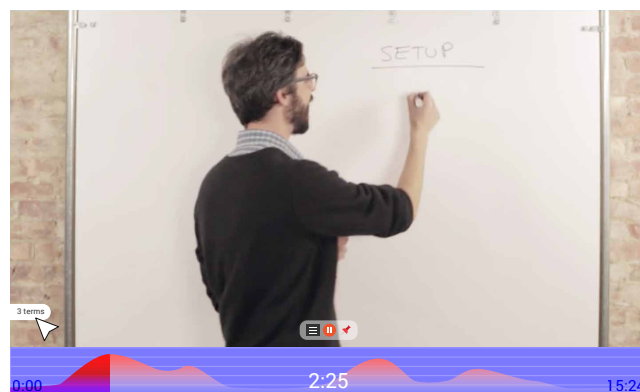


Figure 17.7: As with Brian's case, the interface allows Kate to explore the terms that she is interested in or the terms that she is not familiar with. She clicks the bubble to expand the term.

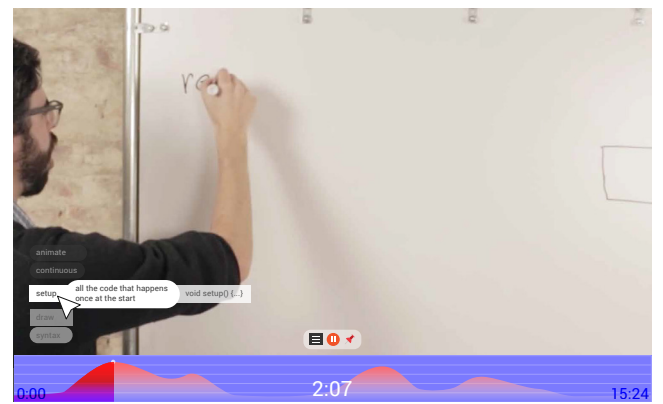


Figure 17.8: When Kate wants the term presented while following the tutorial, she clicks on the term to save it for later review.

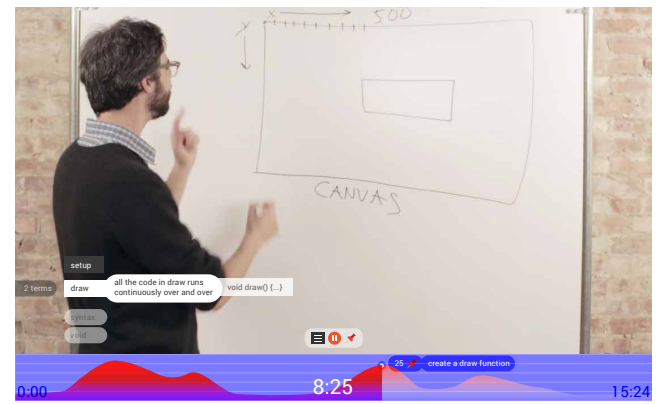


Figure 17.9: The term that Kate does not review hides on the left side of the dictionary list as a dark bubble. The system uses transparency to indicate it is available in a just-in-time manner.



Figure 17.10: When Kate wants to further explore the term, she clicks on it and sees its usage in practical examples, which are gathered from content generated by other members.

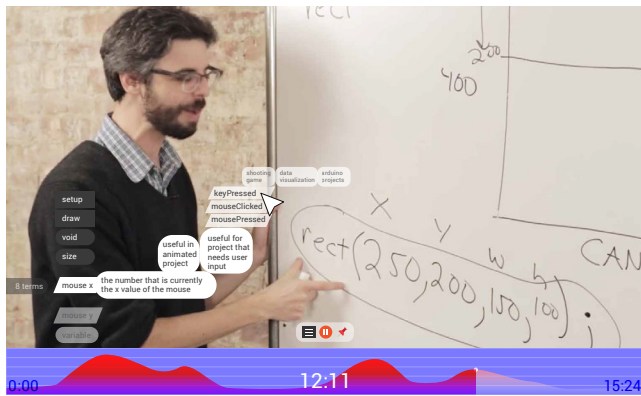


Figure 17.11: Kate can click on the example to see related terms. Then, she can explore related terms by selecting them. Again, the system uses transparency to indicate how far Kate has explored any given term.

CONCLUSION

EACH NOVICE LEVEL NEEDS DIFFERENT TOOLS, FUNCTIONS, AND FEATURES THAN OTHER, MORE EXPERIENCED MEMBERS OF THE ONLINE COMMUNITY

The investigation concludes that there is a need for context-sensitive user interfaces to accommodate different user types. In this case, novices—all of whom are self-motivated and want to learn as a hobby—have different background knowledge and experience, and it is important to acknowledge these differences. Users' differences are not only important for designers and developers who produce an online community platform system to understand; these differences require understanding by the people in the community. If community members notice the different needs of other members, they can better communicate and provide help for those members, thereby lowering barriers to communication.

EVEN IF THE SAME TOOL IS PRESENTED, THE INFORMATION OR CONTENT SHOULD BE DIFFERENT IN ORDER TO ACCOMMODATE LEARNING

The tools, functions, and features of an online Makerspace community can incorporate member-generated information to facilitate user interactions, especially novices of all levels. Some tools, functions, and features can support all novice levels, yet not all novice levels need identical information. Thus, it is crucial to focus on the content that each novice level needs. The interface can adapt to the individual user's needs. For instance, the final visual study shows that although the timeline, the video tutorial, and the dictionary are present for all novice levels, each level requires different possibilities for interaction and information in order to best facilitate specific types of novice users.

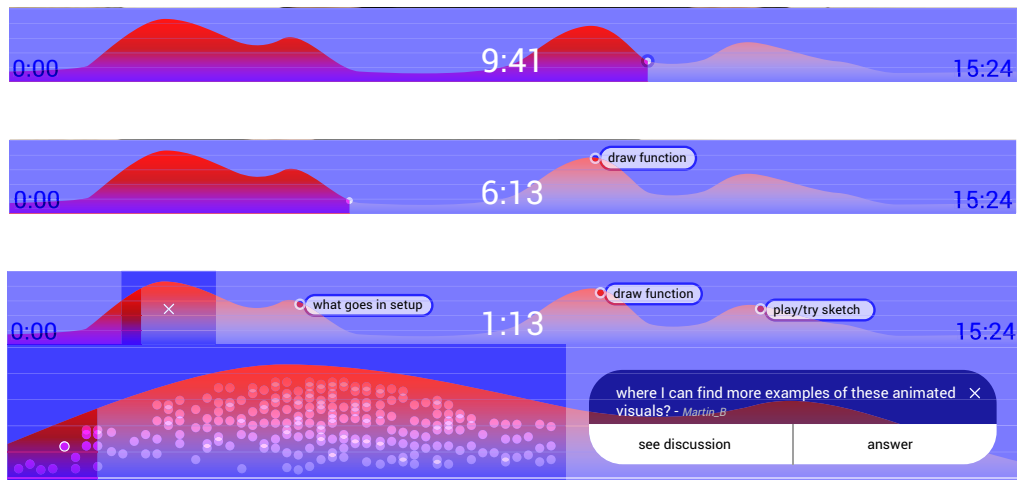


Figure 18.1: Timeline features that reflect different novice levels



Figure 18.2: Differences in the dictionary showing terms that are more expanded for the novice and advanced beginner than the newbie. However, the advanced beginner may want information that expands upon the skills and terms they already know.

REFLECTION

THE COMPLEXITY OF ACTIVITY

The learning process is complex, even if it is not in an educational setting. Thus, this investigation was speculative, while based on research. Several assumptions in this thesis investigation aided the exploration of the question. For instance, this investigation approached the problem by assuming that lowering barriers for communication encourages novices to participate in the community later. Thus, the investigation focused on the dictionary tools.

LITTLE MOMENTS

Since the main focus of this investigation was the information architecture how it presents barriers to communication, I did not examine other features or strategies. Thus, there are more 'little moments' that designers could further investigate—for example, a little moment such as 'introducing oneself' to the community. How can the system provide opportunities for novices to introduce themselves without feeling forced or awkward? However, the question arises whether introducing oneself to others in the online community would truly help lower barriers to communication—although most existing platforms currently encourage such behavior.

PRESENCE OF COMMUNITY

Since this investigation assumed that community presence was important for newcomers to learn, and based on the Community of Practice framework, it raises questions over how the community is presented. When novices saw the historical content generated from other members, what might give novices incentives to interact with other members? This investigation did not deeply address how the presence of other people can encourage novices, as the focus was on the delivery of the information. Thus, this aspect of community experience can be further investigated.

FURTHER QUESTIONS

This investigation only touched on particular moments and only addressed one aspect of lowering barriers to participation. It raised several questions that could be further investigated. The following discussion provides a few examples for further consideration.

CROWDSOURCING INPUT:

This investigation only addressed the delivery of information. Thus, it would be interesting to think about how the community inputs their information and how the system responds to.

THE ORIENTATION OF THE SYSTEMS WHEN THE NOVICES ARE MOVING BACK AND FORTH THROUGH THE GRADIENT:

I agree with the point that the novice moves back and forth among the levels indicated in the Novice Gradient. Each person takes different amounts of time to be comfortable with his or her skills. Even within the same video tutorial, if the individual skips some part and gets confused (meaning, they are moving up and down the gradient), how would the system respond? For instance, when the advanced beginner who knows the programming language leaves the community for a while, and later, comes back, would the advanced beginner lose some of their gained experience? Or would the system consolidate their experience such that the advanced beginner remains at the advanced beginner stage?

AI VERSUS CONTEXT-SENSITIVE INTERFACE:

There is a question about the differences between Artificial Intelligence (AI) and “smart” interfaces—the contextual interface in this case. In this investigation, the system of the interface acts as a mediator between the community as a whole and the novice. This relationship raises questions about the possibility of AI as the system: how would the novices and the community interact or connect with each other? Would AI interfere or help with communication, and how?

APPENDIX

INTERVIEW

INTERVIEW: FACILITATORS AT THE MAKERSPACE

Lauren Di Monte is an NCSU libraries fellow, a librarian at NC State. Her educational background is in visual studies and disciplinary studies from the University of Toronto. She has been working at library ever since her undergraduate study. While she is working with the library there, she is responsible for instructional technology; she helps people who are interested in teaching with technology tool to get started. During her master study, she gets to participate in a research that required different maker skillsets, such as Arduino and some other circuit board tools. After receiving her master degree, Lauren has been working as the NCSU libraries fellow.

FINDINGS

From the interview, two things stand out: first, the community of the makers and, second, the teaching model that the facilitators at the Makerspace go by while running the workshops.

Even though the Makerspace hosts and facilitates several events, workshops, and course work in each semester, the Makerspace does not have to do a lot of advertising. The facilitators often reach out to people who have done different type of projects using different types of making tools. People, whom they reach out to, are all willing to come out, give a talk, and lead a workshop. Although the Makerspace gets small funding and use that fund to pay for speakers' expenses, some of the speakers do not want the money.

Lauren says that what the Makerspace does is focusing on beginners, since most people who go there are looking for helps to get started. Thus, they pivot toward the basic information they need to know to get going. In addition, the hand on activities that students can complete can lead them to take the next step. Thus, empowering people to go and explore on their own is very important model for the space. She remarks that it is important to remind ourselves that everyone is a beginner in different areas, even if you have experiences in something. Thus, providing the first step that would allow them to explore is very crucial for learning something.

OBSERVATIONS

MAKERSPACE: SEWING WORKSHOP

INTRODUCTION:

The facilitator started of the workshop with introducing herself. She remarked that it was important for her to get to know the participants because she would know how to approach participants and how to deliver the information. She wanted to know the participant's name, knowledge background (in this case is academic background such as participant's major because of the setting of the event), past experience with sewing, and participant's goal of attending workshop. Then, she described the

goal of the workshop. For instance, the facilitator showed the pouch that all participants would be making and had that pouch be takeaway thing.

CONTENT:

The workshop covered the explanations of functions of the sewing machine and its part. The facilitator showed a video online that explained what each part of the sewing machine was called and the function of each part. Before the video began, the facilitator insisted that the participants had to listen to the video carefully and tried not to look at the sewing machine in front of them during the video because the sewing machines available in the makerspace had some degree of differences. After the video, the facilitator asked the participants to point at the parts of the machine when the facilitator said the name of that part. This short assessment was a way to ensure that all the participants were in the same page. The facilitator encouraged the participants to touch and try moving/operating each part of the sewing machine through a small quiz. The participants looked around when they were not sure how to operate it. The participants who sat next to each other often communicated when each of them had questions or was unsure. After explaining and testing how to operate each part of sewing machine, with some variety in the machine, the facilitator then introduced the hands-on activity.

HANDS-ON ACTIVITY:

The facilitator first provided a small piece of fabric for the participants to practice. Each time the facilitator introduced new steps, she asked the participants to either point out or reach of the material, tools, or machine parts that were associated with that new step as a way to provide a trial-error experience for participants. After practicing on the scrap fabric, the facilitator provided the material for making the pouch. The fabric for making the pouch was cut to size and already had the hole done. In other words, the difficult parts or easy parts, such as making a hole for the strings, was already done/provided by the facilitators in order to save time.

OBSERVATION: THINK AND DO QUALITATIVE RESEARCH AND R WITH DENAE FORD (LIVE MAKERSPACE WORKSHOP)

A special workshop in the Making Space event series targets women in STEM and raises awareness of tools and technology among women. The first part of this workshop is called Think, which the speaker talks about her research. Do is the second part of the workshop where participants can get hands-on experience with basic programming with R, which is a programming language used in statistical analysis in many research fields.

FINDINGS

From the observation, the word choices can encourage participants to

take part in conversation and engage in the hands-on experience. Not only the word choices, but also the presence and how the facilitator conducts herself can ease the participants in learning new skills.

Part 1 - Think: During the presentation, the speaker tries to post questions for the participants. At first, the speaker says that she will give out candy for people who are willing to answer her questions

Part 2 - Do: During this hands-on activity, participants ask for help when they are lost, not be able to follow when the speaker demonstrates. The two librarians offer to help as they have more experience with R programming. The speaker also shows resources and provides cheat sheets for participants. Other than helping participants, the speaker also posts questions accordingly to get participants to be engaged.

Word choices: The speaker uses casual conversation. She uses the sense of humor and a lot of affirmative words or phrases. For example, the affirmative words are 'simple,' 'no need to fear,' 'play around and see what works,' 'you are fine right there,' 'no worries,' 'we can help each other,' 'keep class engaging,' 'start from zero,' 'same page,' and 'open environment.' The speaker uses the sense of humor such as 'Wrinkle your nose if you don't want to raise your hand' and 'Creepy slide that wake people up.'

Questions

Novice	Beginner	Advanced Beginner	Competence	Proficient	Expertise
	What is it? What is it called? (parts/components) Where is it? How do I find it? How to operate it? What functionality does it do? What can it do? ----- Am i doing right?	What am I doing wrong? Why is it not working like what others did? How to fix the things that I have messed up?	Part where I have little experience with: • What it is called • What it does • How it works with things that I already know • need to refresh memory ----- Part where I already have prior experience: • How does it connect? • How does that part contribute to the part I have just learn?	Is this similar to what I have already know? Why do I use this over something that I have already know? Benefits/disadvantages? — comparison Would this help with the making/project that I want to do?	How it is different from that? What can this do that the prior knowledge cannot do? What are the references/manual page? ----- What else? I think I know that part What would I gain from this? What other strategies? What are other resources?
Workshop that I have been to	Dial Tone (synthesizer part)	Sewing (hand-sew & see someone does it)	Arduino Wearables Internet of Things	R	Processing
Note	- problem with self-identifying? - Beginner stage is short-live?				

LIST OF FIGURES

Figure 1: Community of Practice diagram based on Wenger's levels of participation (Wenger-Trayner and Wenger-Trayner, 2011)

Figure 2: Activity theory diagram based on Meredith Davis' discussion in *Graphic Design in Context: Graphic Design Theory*

Figure 3: 5 stages of adult skill acquisition based on Dreyfus' discussion in the Five-stage Model of Adult Skill Acquisition

Figure 4: the Novice Gradient conceptual framework based on Community of Practice, Activity theory, and the Five-stage Model of Adult Skill Acquisition

Figure 5: the general structure and flow of the current maker events (especially the workshops organized by the Makerspace)

Figure 6: User journey map based on observations and interviews with participants at live Maker events.

Figure 7: existing precedents ranged from 'individual learning' platforms to 'community learning' platforms.

Figure 8.1: The highlight feature suggested the importance of the presented information. In other words, the highlight anticipated the action that related to the current elements or information.

Figure 8.2: The archival feature gathered information such as the amount of time the user spent on the website, the achievement or activities the user completed, and where the user stopped. The archival feature then reflected this information back to the user as an activity log. The level feature considered achievement to determine the user's rank. Then, the level reflects that information by suggesting the appropriate elements. The users could also self-assess to determine their level.

Figure 8.3: Gradients could reflect changes from one level to another, based on the user progress.

Figure 8.4: A timeline generally indicates the progress of time on video content or the progress of the user. Thus, the timeline can suggest important achievements or events. The timeline could also suggest the popularity of activities.

Figure 8.5: The dictionary feature could be useful for novices to learn terminology to effectively communicate with other members. In addition to

providing definitions and related terms, the dictionary can suggest the terms that are more relevant to the context.

Figure 8.6: The annotation feature could indicate the importance of specific content or elements. Further, it could provide an opportunity to personalize user information, including the ability for users to add personal notes.

Figure 8.7: There are many ways to search for information. For instance, by keywords, tags, familiarity (this search would be related to the level feature), suggestions (also related to the level feature), relevance, and popularity.

Figure 8.8: Visualizing the connections between people could indicate that a user is part of the community. The connection feature could indicate members who have more activity or influence in the community. However, it is important to think about ways to encourage novices to communicate with members who are more willingly or likely to help. These helpful members create a friendly environment for the newcomers.

Figure 9.1: Users have an option to annotate or "pin" the video where they think it is important or when they wish to annotate by adding their personal notes.

Figure 9.2: As the video mentions terms, the dictionary displays those terms in real-time. Users also have the option to pin and annotate the terms.

figure 9.3: combining level and gradient to show the current level and progress, as well as suggestions to what the users could explore next.

Figure 9.4: Since terms often relate to other terms, the connection feature could explain that relationship. Combined with the hierarchy of level feature, this diagram suggests the possibility of considering appropriateness of terminology with regard to the different novice levels.

Figure 9.5: The highlight suggests place where each novice level might be more comfortable to interact or explore. The hierarchy of the level suggests the progress of the users.

Figure 9.6: This figure suggests a new way to visualize the chat function by combining the connection feature, the gradient feature and popularity. This figure visualizes the moment when users

are engaging in the chat feature. The larger the circle, the more responses an individual has replied to or engaged in during conversation. The gradient suggests the progress of that individual (i.e., the darker red the circle becomes, the more experienced is the member).

Figure 10.1: The system shows options and suggestions based on user progress.

Figure 10.2: The system suggests the novice starts with working on a project. Thus, the system asks if the novice has a project they want to make or if they want to learn from existing projects. If the novice chooses to learn from an existing project, the system suggests content that is appropriate for novices. From there, the novice can learn the concepts, terminology, or rules from those projects. However, if the novice already has a project in mind, they can choose to explore the concepts, rules, and terms by selecting keywords related to the project they want to make. From there, the system suggests related terms and concepts for the novice to explore.

Figure 10.3: The system provides similar 'touch points' as those displayed for the novice, but it includes self-assessment features for the advanced beginner to rate knowledge built upon past experience; they can then decide whether they want to skip that content or not. The system thereby tailors information that is more interesting to advanced beginners.

Figure 11.1: When the newbie accesses the video tutorial, the video will start playing and the terms will generate. As the newbie watches the tutorial, he or she pins the time and terms and then annotates the information at that time. When the video tutorial mentions that the newbie can try replicating the making activity (in this case, programming in Processing), the space for that task appears. The space includes a section for inputting code and the result section.

Figure 11.2: Novices can search for projects of interest as a way to learn or gain more information. The system suggests contents based on level if the novice toggles on the level filter. The novice can sort the projects by popularity, relevance to interests, and novice level.

Figure 11.3: The system highlights the word to change for clearer communication by a red underline. The interface suggests corrections by displaying alternative words for replacement.

Figure 11.4: The first screen shows all the sketches that other members have shared. The second screen is where the novice enters information, such as title, detailed descriptions, the code or program, and displays the output. The novice can provide tags for other members as search terms. Lastly, the novice indicates how long he or she wants a sketch to remain public and who can see that sketch.

Figure 11.5: The interface reports the progress that the advanced beginner has completed during interaction with the system or the community.

Figure 11.6: The system includes a specific space and section on the forum for newbies to make introductions. Newbies can indicate whether they want to share information, such as their locations and interests to the rest of the community. Once a newbie shares the introduction entry, the system records that information and saves it the archive.

Figure 11.7: The system provides information about the chosen project. The system includes the translation panel for the advanced beginner to explore. When the advanced beginner types in the remixed code, he or she can choose to translate the remixed version into a programming language with which they are more familiar.

Figure 12: various iterations of visualizing timeline and member-generated information

Figure 13.1: Screenshot of Processing website

Figure 13.2: Screenshot of Processing software

Figure 14: A diagram created in collaboration with April Maclaga. This diagram reflects the input and feedback system of the technology, which in this case is the contextual interface, specifically the video tutorial, the timeline, and the menu features.

Figure 15.1: After Ann logs into her account and selects her first tutorial to watch, she sees this screen. The right side of the interface shows Ann that she has access to the community whenever she needs help. The panels include conversation (the chat panel), peek at others (to see other active people who are also doing the tutorial), discussion (show what the community is up to), and next step (which provides pointers for Ann when she is done with the tutorial or if she wants to skip).

Figure 15.2: Ann clicks on the caption icon to turn on the dictionary tool.

Figure 15.3: Ann sees the terms the system generates. The system generates the

terms based on the content of the video. Note that the shape of the term indicates the type of term, and gives Ann visual cues to which term is consider a general concept, a function, a parameter, etc.

Figure 15.4: when Ann click on the term, she sees the definition of that term and a line shows a connection about her current term and anticipated term that is mentioned later in the video.

Figure 15.5: the interface also shows Ann the connection between the current term and the previous term that she has previously learned. The interface indicates the connection by a red line.

Figure 15.6: When Ann see the connection of terms, she can either click on an option and skip back to the time where that term was first mentioned if she is still unsure about the term.

Figure 15.7: when Ann clicks on a peak of the curve in the timeline, the timeline shows information that is generated by other members who have completed the tutorial and those who are still doing the tutorial. The peaks of the curve indicate the importance of the content in real time.

Figure 15.8: when Ann clicks on the curve in the timeline, the timeline will still respond to that action by giving her more information.

Figure 15.9: When Ann reaches the end of the video, she sees how the terms that she learned in the video build up over time.

Figure 15.10: The full screen of how the content builds up over time.

Figure 16.1: Brian sees the white bubble on the left side of the screen saying "1 term."

Figure 16.2: Brian becomes curious about the white bubble, and clicks on it. Brian also notices that the system suggests a spot where he can skip over sections to view material interesting that is interesting to him.

Figure 16.3: after Brian clicks on the bubble, it expands; he sees several terms that were hidden. He decides to click on the suggestion to skip over the introduction of the tutorial.

Figure 16.4: After Brian skipped over to] parts of the video, he clicks on the term that he wants to explore further. The term shows the definition and a suggestion for syntax (the lower opacity bubble on the right of the definition bubble).

Figure 16.5: Brian selects the terms that he already knows to hide them.

Figure 16.6: Like Ann, Brian can click

on the peak of the timeline curve to see what other members commented in the tutorial at that time.

Figure 16.7: Brian can click on a term to explore more of examples that use this term in the code. He then selects an example

Figure 16.8: The system shows more terms related to, or used in, that example so Brian can better understand what the project is about, and decide if he wants to complete that project, or if he knows all the terms he needs to complete it.

Figure 17.1: As with Brian, the interface hides the term that Kate does not need to see.

Figure 17.2: As the video tutorial plays, the system suggests points of interest where Kate can skip forward. Kate also notices a plus sign.

Figure 17.3: Kate clicks on the plus sign.

Figure 17.4: The system zooms into the timeline visualization, where Kate can see all the instances where other members have inserted pins, as well as where they had asked for help or other questions.

Figure 17.5: Kate wants to know more about a question and its answers. She clicks on the circle representing the instance to see what actions she can access.

Figure 17.6: Kate can choose to either explore the discussion on her chosen question, answer that question, or resume the video. Kate decides to resume the video.

Figure 17.7: As with Brian's case, the interface allows Kate to explore the terms that she is interested in or the terms that she is not familiar with. She clicks the bubble to expand the term.

Figure 17.8: When Kate wants the term presented while following the tutorial, she clicks on the term to save it for later review.

Figure 17.9: The term that Kate does not review hides on the left side of the dictionary list as a dark bubble. The system uses transparency to indicate it is available in a just-in-time manner.

Figure 17.10: When Kate wants to further explore the term, she clicks on it and sees its usage in practical examples, which are gathered from content generated by other members.

Figure 17.11: Kate can click on the example to see related terms.

Then, she can explore related terms by selecting them. Again, the system uses transparency to indicate how far Kate has explored any given term.

Figure 18.1: Timeline features that reflect different novice levels

Figure 18.2: Differences in the dictionary showing terms that are more expanded for the novice and advanced beginner than the newbie. However, the advanced beginner may want information that expands upon the skills and terms they already know.

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