

EXPLORATION OF INFORMATION SHARING STRUCTURES WITHIN
MAKERSPACES: A MIXED METHODS CASE STUDY OF
DALLAS MAKERSPACE AND ITS USERS

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Makerspaces are a popular, new concept being implemented in public, academic, and school libraries, and as stand-alone spaces. The literature reflects the newness of the topic with a limited number of articles and studies and even less about the users of makerspaces themselves. This study explored information sharing behaviors in the Dallas Makerspace as an informal learning environment and described their preferred method of information transfer from one member to another. It employed a mixed methods methodology using surveys, interviews and observations. The study identified how the rules and policies in place at the makerspace influence the information seeking process and how the Dallas Makerspace exchanges information effectively. Dallas Makerspace is one of the largest non-profit work groups in its size, and this research study answers how information is exchanged in an informal environment.

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CHAPTER 1

INTRODUCTION

Background

The term makerspace is relatively new. *Make* magazine began in 2005 and started “maker faires” in 2014 as part of the “maker movement”, and the term emerged in 2012 “out of do-it-yourself (DIY) culture”. (Britton, 2012, p. 30). While the term is new, the concept is not and has been expressed in different forms, such as tech labs, learning environment, learning commons or hackerspace. The reasoning behind makerspaces stems from a collaborative learning environment or workspace. The concept of a learning environment was developed to provide a safe and open environment where students could explore, learn, and create. Learning or information commons were introduced in the late 1980’s by Michigan’s Jackson Community College (Accardi, Cordova & Leeder, 2010, p. 311) and were quickly adopted in many academic institutions with an emphasis on technology in the learning and research space.

Hackerspaces originated from hack-a-thons, in which the participants would be given a computer code to break into, and people could either compete alone or in teams. The concept was also used to create code, and participants would spend a weekend writing lines and lines of code for a product or website.

The philosophy behind all of these concepts is to encourage collaboration and a safe environment for trial and failure. It exemplifies that having an active community and supportive environment will turn ideas into reality. As the concept of “making” becomes more and more popular, the terms are constantly evolving, and there are opportunities to adapt these simple concepts into a thriving community that supports one another.

Martinez and Stager (2013) authors of *Invent to Learn: Making, Tinkering, and Engineering in the Classroom* state,

There is no absolute shopping list of must haves. There is nothing that is a fatal flaw if it's missing. Making do with what you have is a virtue. If you can't afford a 3D printer, don't have the perfect space, or are a bit fearful of electricity, you can still create and experience that is comfortable, and fun for your students (p. 62).

Using the culture of making, schools, universities and public libraries are implementing Makerspaces to teach hands-on STEM (Science, Technology, Engineering, Mathematics) concepts, like circuits or bridge building. Lauren Britton coined the term makerspace in 2012 and based her term definition on guided inquiry principles, learning environments and hackerspaces. The literature reflects the newness of the concept with the search term makerspace returning articles from 2012 at the earliest. Lauren Britton (2012) developed the concept of makerspace or "Fab Lab" in a public library as part of her thesis at Syracuse University. One of the key components to the success of a makerspace is the buy in not only by staff, but also the users (Britton & Considine, 2012; Moorefield-Lang, 2015).

The literature highlights how the users may use the space and general information on how to create a makerspace in specific types of settings, school or public library, but does not reflect information about not for profit makerspace or its users. These informal spaces have been around for years, but there are few studies about them. An example of the literature is an article by Slatter and Howard (2013) that emphasized the community impact from a makerspace that was implemented in an Australian public library and changed the library from a place of consumables to a place of creation. However there was a distinct lack of studies revolving around makerspaces and even less about collaborative learning. There were no studies about the users of

these standalone spaces and their interactions within the space. According to Moorefield-Lang (2015) the spaces are gaining popularity across the country in a variety of settings such as schools, public libraries and as free standing spaces.

The Dallas Makerspace is a vibrant organized community of, but not limited to, makers, artists, engineers, and thinkers that engage in creating and learning at the facility that provides tools and space (Dallas Makerspace, 2017, webpage). The makerspace “use[s] these resources to collaborate on individual and community projects in order to promote science, technology and art; while working and experimenting on innovative ideas to encourage learning within our community” (Dallas Makerspace, 2017, webpage). The mission of the Dallas Makerspace is: “we believe that collaboration is a truly effective form of learning. To that end, our members and volunteers teach classes, hold unique educational events and collaborate on cool projects” (Dallas Makerspace, 2017, webpage). Based on the mission statement and that membership has been increasing for the last two years, the question that arose was: how are Dallas Makerspace members exchanging information within the facility? This study evaluated the information exchange by members of the Dallas Makerspace and if it is dependent on social networks.

While the tools and facility are only available to members of the community, the classes are open to the public unless otherwise specified on the signup sheet. The members teach classes about jewelry, pottery, screen-printing, laser cutting and more! Many of the classes are free, but some do require a fee, and facilitating the classes in this format allows the facility to give back to the community by teaching skills in an affordable way. A member shared an example of their use of the facility: the member

had recently moved to the area from College Station after graduating from veterinary school and he had moved into an apartment that did not have a standard shaped dining area. The member sought to purchase a table from a store or online retailer, but was amazed by the prices and did not want to pay their amounts. Therefore he decided to create his own table, but his landlord did not allow the types of tools in the apartment complex. The member turned to the internet to look for a workshop or store that had workspace to build his table and stumbled across the Dallas Makerspace in his searches. He took one of the weekly Thursday night Open House tours and signed up to become a Dallas Makerspace member on the spot! He quickly designed a table that fit his dining space and took the required classes to use the tools needed to create the table. He also met other members who were woodworkers and provided tips and guidance during the process. He built his table, stained, and personalized it for less than \$50, which would have cost him several hundred to custom order it. Because of the information exchange structures in place at the Dallas Makerspace, this member was able to find information in a quick and efficient manner to achieve his goal. The question is how are Dallas Makerspace members exchanging information within the facility?

Information exchange is the act of a person seeking or sharing information to fill a void in their knowledge and may be understood as “the flow of information or knowledge transfer” (Pilerot, 2015, p.6). Information exchange can be referred to as information sharing or transfer. Information exchange is essential to the success of societies to allocate resources, enhance living situations, and share techniques. In nomadic times, the information exchange meant the difference between life and death as tribes and societies shared information about herds and new tools. In recent times,

information exchange has transformed from the time-honed tradition of oral stories and books to new formats, such as, Facebook and Twitter. Makerspaces, both formal and informal, have arisen as a new place to facilitate the exchange that encourages creativity, collaboration, and problems solving techniques.

Makerspaces thrive on sharing information, and the information exchange is essential to fully functioning facilities to be able to sustain themselves. The sharing of information is, in part, influenced by the social structures that exist within the boundaries of each makerspace. The Dallas Makerspace's social culture shed light on the information exchange and retention in an environment without obligation to share and retain information in a formal organization.

Makerspaces are formal or informal, collaborative work spaces that can be housed in schools, libraries, other institutions, or may stand alone as its own entity, and embody the long standing concept of guilds which are considered "social activity, shaped by communal resources and motivations" (Bonanni & Parks, 2010, p.180). Makerspaces are described by Sheridan, Halverson, Litts, Brahm, Jacobs-Priebe, & Owens (2014) as "informal sites for creative production in art, science, engineering where people of all ages blend digital and physical technologies to explore ideas, learn technical skills, and create new products" (p. 506). Makerspaces encourage multiple learning styles thus appealing to many types of people with their wide range of flexibility for use and the ingenuity inspired. Though one may think of a makerspace as being tied to a physical location, this is not necessarily so. They may be something simple such as a cart that a teacher rolls into and out of their classroom or they may be a group that meets at a person's house to work on making a quilt together. A makerspace is

wherever “making” is taking place. Makerspaces host information seekers that are driven by their levels of interest and to share information, learn, and be creative. Using information seeking skills, active members of makerspace communities use their curiosity to speculate and dream of new and innovative solutions to problems. Using information behavior models and social network analysis will help to identify information sharing in makerspaces and answer the research question how information seekers are connected to information providers in a makerspace and how information seekers seek information in makerspaces.

Research Setting

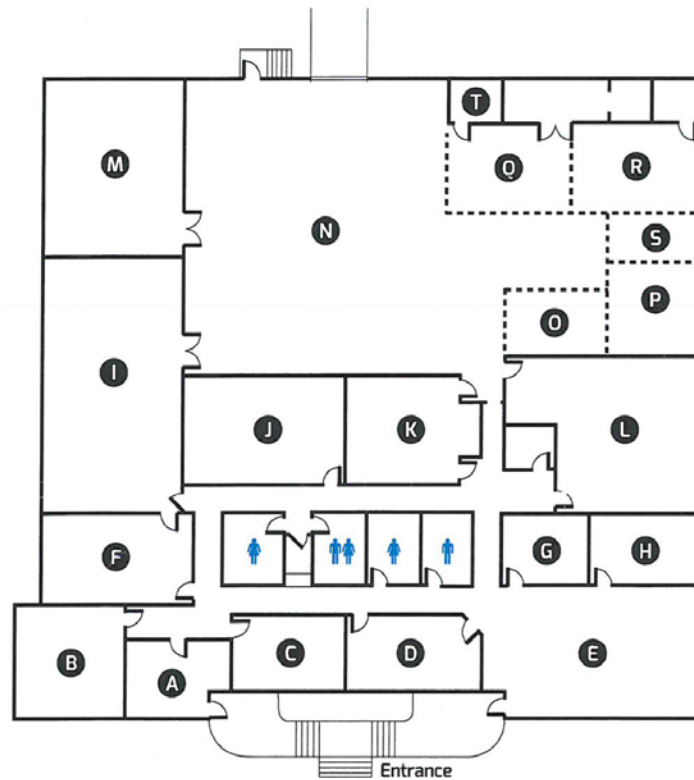
The Dallas Makerspace is a 501(c)(3) non-profit collaborative community that shares a community workspace located in Carrollton, Texas. It was founded in 2010. The community boasts about thirteen hundred members, but only about three hundred are active members who use the space on a regular basis. The makerspace resides in seventeen thousand square feet at 1825 Monetary Lane and hosts an open house every Thursday night to welcome and attract new members and twice a year they have an anniversary open house (Dallas Makerspace, 2017). The community provides tools, which would otherwise be hard to access, and a space for collaborative projects to be implemented. Membership dues, donations and class fees that apply to the public and members of the makerspace sustain the Dallas Makerspace.

The makerspace provides a number of different classes based on the expertise of their members, such as Spinning and Fiber Arts, Robot Builders Night Out, and Laser Basics + LaserSaur, Epilg & Thunder classes (Dallas Makerspace, 2017). The

community is administered by committees, which vote every two years on positions such as president, vice president, and treasurer.



DALLAS MAKERSPACE
OPEN HOUSE 2016



MAP KEY

- | | | |
|-------------------------|-------------------------|----------------------|
| Ⓐ LOBBY | Ⓗ DIGITAL MEDIA | ⓓ SCIENCE |
| Ⓑ ELECTRONICS | Ⓘ WOOSHOP | Ⓟ VECTOR |
| Ⓒ 3D FABRICATION | Ⓝ CREATIVE ARTS | Ⓠ MACHINE SHOP |
| Ⓓ TINY PURPLE CLASSROOM | Ⓚ LECTURE HALL | Ⓡ FIRED ARTS |
| Ⓔ COMMON ROOM | Ⓛ INTERACTIVE CLASSROOM | Ⓢ JEWELRY |
| Ⓛ GALLEY | Ⓜ METAL SHOP | Ⓣ HATCHER'S WORKSHOP |
| Ⓜ MEETING ROOM | Ⓝ WAREHOUSE/AUTOMOTIVE | |

DALLAS MAKERSPACE · 1825 MONETARY LANE, CARROLLTON, TX 75006

DALLASMAKERSPACE.ORG

Figure 1. Layout of Dallas Makerspace (Dallas Makerspace, 2017)

The location is an industrial area of Carrollton and the layout of the makerspace is a series of rooms devoted to different specialties before opening up to the open workshop area (see Figure 1, N Warehouse/Automotive). To access the building a badge is required, which permits the member to access the space twenty- four hours a day. The space hosts an electronics room, a 3D printing room, a Digital Media studio, a calm area, a lecture hall and classroom, and the purple room, which has different displays or collaborative projects. For example, in September, the purple room displayed restored pinball machines that the members either own and restored or had been donated.

To understand the information exchange happening within the Dallas Makerspace facility, one must understand the layout. Once inside, there are two rooms, on the immediate left and the right, that lead to electronics and 3D printing. Past those rooms are two hallways that lead to the large work area and digital media, the other branch leads to the Creativity Studio, lecture hall, and interactive classroom. Both end at the entrance to the workshop, which again requires the use of a badge to gain access.

The electronics room uses donations from old electronics and supplies purchased by members to create with soldering irons, wires, and computers to code. For people new to electronics and circuitry, they start with a simple concept like paper circuits, which uses copper tape, a 3V battery, and a LED bulb. The 3D printing room across the hall hosts a 3D printing training session every couple weeks for those who want to 3D print. The committee hosts 3D design classes approximately once a month about different 3D modeling programs, such as Blender or Autodesk 123D Design. The

group has purchased several different types of 3D printers, such as PolyPrinter, and Ninja Flex.

The calm area is a space for people to work and socialize. Some committees hold their meetings there and many people come in to work on individual projects that do not need special equipment. Next to the calm area is the Digital Media studio, which hosts podcasting equipment, blue screen, photo and video editing, microphones and music equipment. Members of Dallas Makerspace donate a large number of volunteer hours to teaching classes about use of the equipment owned by the group.

The final space is the workshop which is host to a myriad of different equipment and specialty areas. Within the workshop is the Hatchers studio for gun smiths, ceramics, small metals, automotive repair, lasers, metal shop, woodworking studio, and creative arts. The Chair of the Hatchers studio is a competitive long range competition shooter and the committee teaches members how to load a gun, how to repair antique guns, or how to long range sight. The workshop also contains the small metals area, jewelry area, and ceramics area in a corner of the workroom. There are blow torches, kilns, throwing wheels, magnifying lights, glass design tools among many other tools. The laser cutters are one of Dallas Makerspace's newest acquisitions and one the group made from pieces in the shops as well as one that was purchased. Laser cutters can etch designs, cut specific designs in all types of materials, and create burn designs. To use the machines, the member must attend a training session. The trainings are held on a weekly basis with a variety of available times and days.

The Dallas Makerspace is managed by a structure of committees, and each committee offers classes for their area of specialty, works together on projects, and

maintains the equipment. The woodworking committee recently installed a dual dust vacuum that keeps the workshop area clear of sawdust when they are working. The metal shop installed a fire ventilation system so the fire marshal would approve the installation of C&C Plasma Cutter.

Other committees use the space to meet and work on projects, rather than large tools. For example the robotics team meets weekly to work on building a robot for a tournament. The Science Committee meets every quarter to put together a group of projects that they are going to work on for several months. The Aerospace Committee designs small toy planes to fly together, and with each new plane they tweak the design to make it more aerodynamic. The Automotive Committee forms a group every year to build a car for less than five hundred dollars to race in a competition similar to Le Mans, the French car race that tests a car's endurance over 24 hours.

Problem Statement

According to *Popular Science*, there are 1,393 spaces identified as makerspaces in the United States as of February 2016 (Lou & Peek, 2016). This number has risen in the past decade from about one hundred makerspaces in 2006 to the current count, increasing the number of makerspaces roughly fourteen times. Makerspaces, or collaborative work groups, are considered open systems, similar to the concept of guilds. As an open system the information flow is constant, members of the Dallas Makerspace are continually seeking information to fill an information need and sharing information with those with the information need.

The Dallas Makerspaces' continued prosperity is dependent on its members finding information. The organizations' rules and policies require members to take specific classes to use the tools and technology that are housed within the facility. The information exchange is an essential part of the continuance of the Dallas Makerspace and their rules and policies are based on this concept. Makerspace is an open system that "continuously exchanges mass, energy, and information within its environment. This steady state of exchange with its environment makes it possible for the open system to grow, specialize, differentiate, and become more complex" (van Wormer, Besthorn, & Keefe, 2007, p.17). Open systems are based on a certain level of trust and interaction on a continuous basis. Once that comfort level has been reached, people "would seek out a steady state of exchange to better reach their potential- manifesting ongoing curiosity, self-development, new skills, and meaningful activities" (van Wormer et al., 2007, p. 17). From this, the question arises, how is the information exchanged?

Research Design

This mixed methods case study addressed makerspaces as informal collaborative work groups. It examined to what extent information is transferred and shared in an environment without any requirements in place to share information among its members, who pay the required Dallas Makerspace member fee and use the space regularly. A mixed methods explanatory design used quantitative surveys to identify the social networks within the Dallas Makerspace. Qualitative semi-structured interviews were conducted with the participants based on the responses provided within the surveys. The quantitative portion has two phases. In the first phase, surveys were

delivered via the forum on the website for Dallas Makerspace members for people who participate in the maker culture, and from the responses a social network analysis was built to address how the information seekers are connected to the information providers in the Dallas Makerspace and if the relationships mutually exclusive or directional.

The Dallas Makerspace was examined to evaluate the extent of their social networks in house. Once the social network was built, semi-structured interviews were conducted for the qualitative portion of the study, and the participants who indicated an interest in expressing their perceptions of the maker environment were interviewed with a goal of one participant interview from each section of the makerspace, such as 3D printing, automotive, and ceramics to identify how information seekers pursue information, how interactive are the seekers and do the roles of information and sharing resources impact the users in their choice of participating in the Dallas Makerspaces community. Their perceptions were used to clarify and explain the responses received in the quantitative portion of the study.

This mixed methods approach addressed the information sharing behavior of members of the Dallas Makerspace. It used the first Wilson model (Wilson, 1999) to guide the development of the survey and interview questions that assessed how much information is shared and how accessible it is in the Dallas Makerspace. The significance of this study was to determine if social networks were impacting the information exchange behavior in a makerspace. Information exchange is comprised of information sharing and information seeking behavior by members of the Dallas Makerspace. Information sharing is how the users are communicating other users about their knowledge and skills. Information seeking is how the users are searching for

information they need to complete projects. The information exchange is how users with the knowledge are sharing that knowledge with the information seekers and how the seekers are conveying their need for the information.

Research Questions

In light of the problem above the following questions of the various ways to share information will be answered:

- RQ1. How are information seekers connected with information providers in makerspaces?
- RQ2. What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional?
- RQ3. How do information seekers seek information within the makerspace? And to what extent is it interactive?
- RQ4. What is the role of information and sharing resources that impact users' choice of participating in a makerspace (i.e. in the physical space, or with interviews)?

To answer these questions, a mixed methods approach was designed that used surveys to analyze the social structures in place at the Dallas Makerspace and semi-structured interviews were conducted and thematic coding was developed to determine the most popular way for Dallas Makerspace members to share information and to seek information.

Significance of Study

Information sharing is a key component to the survival of civilizations. On a smaller scale it helps corporations and industries function at a higher level of effectiveness because there is not a constant repetition of re-making or re-learning

information since it has been retained as people move through positions. Learning from companies and government-funded institutions, information sharing is a vital part of the success of these establishments. While many makerspaces reside in educational institutions or environments where information sharing is required, Dallas Makerspace is not one of those. It is a freestanding entity that relies on the support of the community to share information about equipment and craft skills, such as soldering or pottery throwing. For example, knowledge exchange is a process that brings together academic staff, users of research, and wider groups and communities to exchange ideas, evidence and expertise (Parrino, 2015). Knowledge exchange, in this study, is reliant on the proximity of the makerspace members and according to Amin and Cohendet (2004) the exchanges are also dependent on an understanding of the culture.

The Dallas Makerspace is a successful non-profit makerspace based on the information exchange atmosphere that has been created by the policies and rules in place and a definition of its success is based on the fact that membership has been increasing every year and they have moved to larger spaces to accommodate the increased members. Studies about makerspaces are few because of the newness of the concept, and with the addition of how the information is shared within these spaces as a separate concept, the time is right to study and understand the patterns of information exchange in a community that is built on it.

Limitations of Study

The limitations of this study are:

1. Only one makerspace was evaluated.

2. Skewed data: the survey was only posted on the makerspace online TALK discussion forum.
3. Self-reported data by research participants
4. Lack of previous research on the subject
5. Researcher bias

The first limitation could be overcome by evaluating multiple makerspaces in different types of environments to understand if information sharing is mutually exclusive to social networks in multiple types of makerspaces. Only one makerspace was examined because the researcher wanted to understand how the information exchange improved the Dallas Makerspace's continued existence, while other makerspaces in the Dallas area do not have the same longevity.

The second limitation was limited by where the researcher had approved consent to post the survey by the President of the Dallas Makerspace. It was posted three times on the online TALK discussion forum. The data collection limitation could be overcome by handing out paper surveys during classes in the future to reach a larger and different audience rather than limited to those who visit the online discussion forum.

The third limitation is the data was self-reported by the research participants. The goal is to offset this limitation with the observations that I conducted as part of the ethnographical part of the study.

The fourth limitation is the lack of previous research on the subject. Between 2006 and 2014 makerspaces increased from 100 to 1400 facilities (Lou & Peek, 2016); however, the research studies date back only to 2014 and there is a lack of studies about the information exchange in informal environments. The final limitation is my own bias. As a member of the Dallas Makerspace, I have preconceived conceptions of how I

think the information exchange is occurring. To combat this bias, I had an inter-coder to validate and/or question the thematic coding.

Definitions of Terminology

Through the remainder of this study, use of specific terms and concepts will be based on the following definitions:

- Information sharing- the act of giving knowledge to another through speaking, email, written word or in a classroom setting.
- Information seeking- the act of a person finding the information required by them through a specific process of identifying an information need and then exploring options, such as the Internet or asking another member, to procure that specific information.
- Learning 'isms' or 'ism(s)'- Different types of learning concepts, such as constructionism, constructivism, and collectivism, used to classify how one learns and seeks information.
- Makerspace- an informal space where making or creating takes place.
- Sense-making- the act of identifying that the user is lacking information in a logical order and then following a seeking process to fill the gap.
- Social networks- the identification of the makerspace users' ties in the form of friendship or acquaintanceship.

Research Plan

The purpose of this study is to identify how people in informal environments communicate and exchange information and to determine if the information exchange was dependent on social networks. Multiple stages of the study were conducted and were staggered to get different perspectives from a variety of different people with different interests. Using the survey and interview responses a social network sociogram was created to illustrate the information sharing and information seeking preferences of the participants. Those who indicated interest and willingness were contacted for an interview.

The Dallas Makerspace has three guiding principles that describe who they are, what they do, and why they do it. Their principles highlight themselves as a group that works together to provide learning resources and collaboration for not only their members, but also the public. The organization has grown significantly in membership from 50 to over 1200 since its conception in 2010 and the question that I sought to answer is how are Dallas Makerspace members exchanging information within the facility?

CHAPTER 2

LITERATURE REVIEW

Introduction

Knowledge exchange has been a part of human existence from the beginning of time, necessary for survival to find food and a safe place to sleep. The willingness to share information or exchange knowledge led to the evolution from nomadic tribes to large civilizations with language, customs, and the written word. Within these civilizations, guilds, such as merchants or religious groups, formed and passed down their knowledge to apprentices (Bonanni and Parkers, 2010). Today, knowledge exchange happens in formal institutions, for example universities or corporations, and in informal environments or makerspaces. For the purpose of this study, knowledge exchange is defined as the process of information transfer from one person to another through information sharing or seeking acts.

Information sharing is another term for the information exchange process. According to Wilson (2010) the description of information sharing is where “the user may seek information from other people, rather than systems” (p. 4) and the process does not necessarily involve the sharing of documents. Knowledge sharing is the sharing or transfer of documentation of the information from one person to another (Wilson, 2010). Part of the knowledge exchange process is information seeking, the process of attempting to obtain information by identifying a gap in knowledge, and it “must be understood within a context” (Wicks, 2004, p. 22). For this study the context is the Dallas Makerspace.

The Dallas Makerspace's information exchange concept is defined by three guiding principles, which focus on collaboration. The three principles of the Dallas Makerspace are the "who, what, and why" of the organization. The first principle is defining who they are: "shared community workshop and laboratory. We are an organized group of local artists, engineers, makers, and thinkers who work together to provide tools and learning resources to the public" (Dallas Makerspace, 2017, webpage). The second principle is about what the organization is doing: "We use these resources to collaborate on individual and community projects in order to promote science, technology and art; while working and experimenting on innovative ideas to encourage learning within our community" (Dallas Makerspace, 2017, webpage). The third principle is about why they do it and states: "At Dallas Makerspace we believe that collaboration is a truly effective form of learning. To that end, our members and volunteers teach classes, hold unique educational events and collaborate on cool projects" (Dallas Makerspace, 2017, webpage).

History

Makerspaces, while considered a new concept, have their roots in early 1900's (Oliver, 2016) beginning with such groups as canning or repairing a barn that was destroyed by a fire. The term is new, but other groups use terms such as, but not limited to learning commons, fablab, workshops, hackerspaces, learning environments, studios, camps, and tech shops. The main objective is to give people access to technology, space, and software to encourage ingenuity, discovery, and problem solving: "Drivers of the maker movement include cheap technology, open source

hardware and software, and globalization with different players acting in the maker ecosystem- beginners, collaborators, and market innovators” (Oliver, 2016, p. 161). Within makerspaces key social structures are in place for understanding the dynamics of the group. These social structures relay information, collaborate, and make decisions for the space.

The concept of a makerspace in a public library was developed by Lauren Britton (2012) and was based on the concept of community collaboration; however Hira, Joslyn & Hynes (2014) note that the idea of making has its foundation in 2005 with the introduction of *Make* magazine. Make Magazine was developed to help people with their hobbies (Hira, Joslyn & Hynes, 2014). Halverson and Sheridan (2014) state that “The *maker movement* refers broadly to the growing number of people who are engaged in the creative production of artifacts in their daily lives and who find physical and digital forums to share their processes and products with others” (p. 496). Sparked by the growing do-it-yourself (maker) movement, Britton (2012) introduced the concept of a makerspace in public libraries as a thesis project. She developed concepts for how the public would use the space, and rules for using the equipment, such as attending a 3D printing training session before a user is allowed to use it on their own.

There has been an explosion of maker culture in the last five years as people collectively decide to create these spaces to share with their communities. The maker movement is becoming a permanent part of the culture surrounding museums, libraries, universities, and schools. Many institutions begin building their makerspace from grant funds. The Institute of Museum and Library Services offers multiple types of grants, such as grants for programs or supplies, which institutions can apply for, receive

funding, and implement different makerspace concepts in their space (Institute of Museum and Library Services, 2016). Best Buy, the Bill and Melinda Gates Foundation, Toyota, along with many state library associations offer grants or funding to build or integrate these influential spaces.

Sheridan et al. (2014) notes that, “the maker movement refers broadly to the growing number of people who are engaged in the creative production of artifacts in their daily lives and who find physical and digital forums to share their processes and products with others” (p. 496). Makerspaces are defined as, “informal sites for creative production in art, science, and engineering, where people of all ages blend digital and physical technologies to explore ideas, learn technical skills, and create new products” (p. 506). The concept of makerspaces is to promote flexibility in a learning environment to better suit the needs of the users. People learn in different ways, such as kinetic or visual, and learn at different paces. Many collaborative workspaces include hangouts or a “ ‘campfire’ area to gather for expert presentations or sharing, a ‘watering hole’ area to convene for collaborative work, and a ‘cave’ area to retreat for individual activity or reflection” (Davis & Kappler-Hewitt, 2013; Maker Maker, 2013). While the term makerspace emphasizes the idea of a physical space, it does not have to be a physical space, but a community that is focused on collaboration in any type of environment such as online discussion forums, work groups, or interest driven learning (Oliver, 2016).

Makerspaces inhabit two types of learning environments: formal and informal. In this study, the informal learning environment will be emphasized. Formal environments are part of schools, universities, or corporations and have specific learning outcomes.

Informal learning environments are freestanding entities that do not answer to a higher institution and they have their own policies and rules not associated with an organization. The maker movement is gaining traction, as evidenced in 2014, when President Obama stated, "I am calling on people across the country to join us in sparking creativity and encouraging invention in their communities". These spaces are important to the communities because of what they emphasize: collaboration, creativity, and freedom of expression. Makerspaces are bringing together people from all walks of life and highlighting learning styles that are not traditionally addressed in schools.

People have found many uses for makerspaces. These are varied based on the individual reasons for using the space, such as individual exploration, group collaboration, or team building activities. Some are curious about new and innovative technology, wishing to explore the technology without the expense of purchasing it. Others seek to be innovative by creating a new product or learning a new skill. All makers share one common goal; they come into the space to produce. For whichever reason, curiosity or solving a specific need, when a person walks into a makerspace, they are seeking information and knowledge necessary to satisfy their desire to make. While many associate the idea of a makerspace with technology, this is not necessarily so. Makerspaces emphasize multiple types of learning, particularly the creation of art.

Artists have been making for eons-yet it offers fresh opportunities to join forces on projects and education with people who never considered themselves to be artists... An artist may be already experimenting at the forefront of the field of digital production or might be using two- thousand- year- old techniques. In either case, makerspaces are seeking creators of all stripes (Barniskis, 2014, p.10).

These collaborative spaces are promoting the disciplines of science, technology, engineering and mathematics (S.T.E.M.) and are instrumental in schools and libraries.

More schools and libraries are agreeing to host makerspaces to encourage the idea of the S.T.E.M. process in makerspaces. The growth of makerspaces in schools originated from President Barack Obama's Educate to Innovate (2013) campaign, which kicked the idea of making into high gear (The White House, 2013, webpage). Government entities increased funding available to make these spaces a reality.

The idea of maker fairs, gatherings of like-minded individuals who like to make and share their work, originated in San Francisco about ten years ago and are now hosted across the United States, with the biggest two being held in San Francisco, California and New York, New York. President Obama (2013) stated,

One of the things that I've been focused on, as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math... We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve (The White House, 2013, web page).

S.T.E.M. has taken the United States and makerspaces by storm with many schools rolling out platforms to support this initiative, public libraries creating programs to touch these concepts, and academic libraries creating more welcoming environments for students of these disciplines to come and create.

Some makerspaces have formal user agreements, such as those entities that are part of public libraries or corporate environments, either to protect the users or retain information. However most contain general requirements and restrictions because technology is evolving quickly and there are many unspoken rules that are shared as the member becomes more involved with the space. For the Dallas Makerspace specifically, members have full access to the space and tools 24/7 but some tools have prerequisite classes that members must take before their account is approved to use

the equipment. A member must attend specific trainings to be allowed to use certain machines such as the 3D printer or laser cutter.

There are two other not for profit makerspaces, the Lab (2016) and Tarrant Makers, in the Dallas/Fort Worth area that are independent of other organizations, such as libraries, museums, schools or universities. However, the Tarrant Makers makerspace did not flourish and shut down in 2016. The Lab in Plano had just opened its doors at the time of this study and did not have the community or the time to build the relationships for the information exchange this study was identifying.

The Dallas Makerspace opened in 2010 in a small warehouse in Dallas. As membership grew, it moved to its Royal Lane location in 2013, and to the Carrollton location in 2015. This site was chosen because the organization had established membership and precedence of growth. The members, including two interviewed, were part of the makerspace since its conception.

Human Information Interaction

Makerspaces have information continually exchanging hands, as ideas are born, shared, and reformed through experimenting and curiosity. Makerspaces embody the concept of human information interaction theory, which according to Raya Fidel (2012) is humans, or actors, who interact with information in different settings (i.e. libraries, corporations, or information science fields) as part of the actor's everyday activities. To understand human information interaction, one must define interaction. Interaction happens between two or more things and may be human-to-human, human to computer, human to information, computer-to-computer, information to computer, or any

combination of these. The goal of human information interaction is “for complex information to communicate concepts and ideas to be used in decisions” (Albers, 2015, p.4). And complex situations demand complex human information interaction as shown in Figure 2.

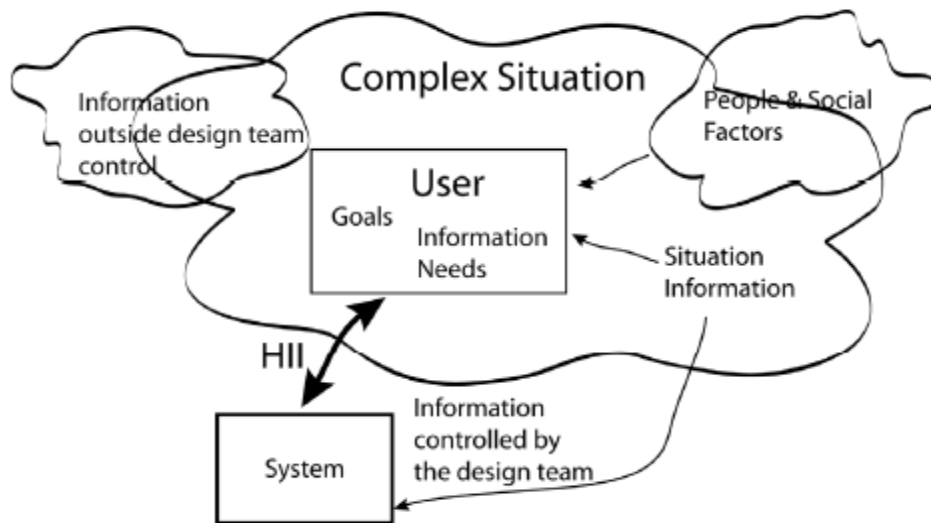


Figure 2. Complex human information interaction (Albers, 2015, p. 7).

There are two steps to identifying the types of interactions occurring in makerspaces: human to human and human to information. First the source supplying the information must be identified, and second the type of interaction is identified. The study identified if the human-to-human interaction was based on social networks in the Dallas Makerspace when people sought information for their own projects or curiosity. Human to information interaction is identifiable by what the humans are using the information for once they have obtained it from a human-to-human interaction. Using the concepts of human-to-human and human to information interactions addressed the question of how do information seekers obtain information and identify how interactive the collaborations were.

The interaction between humans and computers are information behaviors that were first identified in 1973 (Case, 2012, p. 137). Interactions that are human-to-human and human to computer are important to collaborative communities to create trust and encourage teamwork when needed. However, these interactions do not emphasize what and how the information is used once it has been shared. The study sought to understand the human-to-human interactions information sharing patterns within the Dallas Makerspace. The human to information interactions identified how the Dallas Makerspace members were seeking information within the organization. The first Wilson model (1999) and the Byström and Järvelin model (1995) explained the processes that Dallas Makerspace members go through to retrieve the information they are seeking.

Information Behavior and Information Seeking

The First Wilson Model

Information behavior studies first appeared in 1902, but exploded after World War II once the idea of information science was seen as a benefit to society and gained popularity (Case, 2012); however once the initial flurry of interest died down, information behavior papers slowly declined. In 2005 when there was an uptake in information behavior studies (Case 2012). T. D. Wilson (1981) created several models of information behavior models, but the one most pertinent to this study is the first Wilson model, which focuses on the information seeking process. The first Wilson model emphasizes information sharing and those people with whom the information is being shared. Wilson (2000) describes information behavior as,

the totality of human behavior in relation to sources and channels of information, including both active and passive information seeking, and information use. Thus

it includes face-to-face communication with others, as well as the passive reception of information as in, for example, watching TX advertisements, without any intention to act on the information given (p. 49).

While information behavior specifies that the recipient will not act on the information, information seeking behavior is the act of pursuing information with the intention to act on it and use it in an effective way to the user (Wilson, 2000).

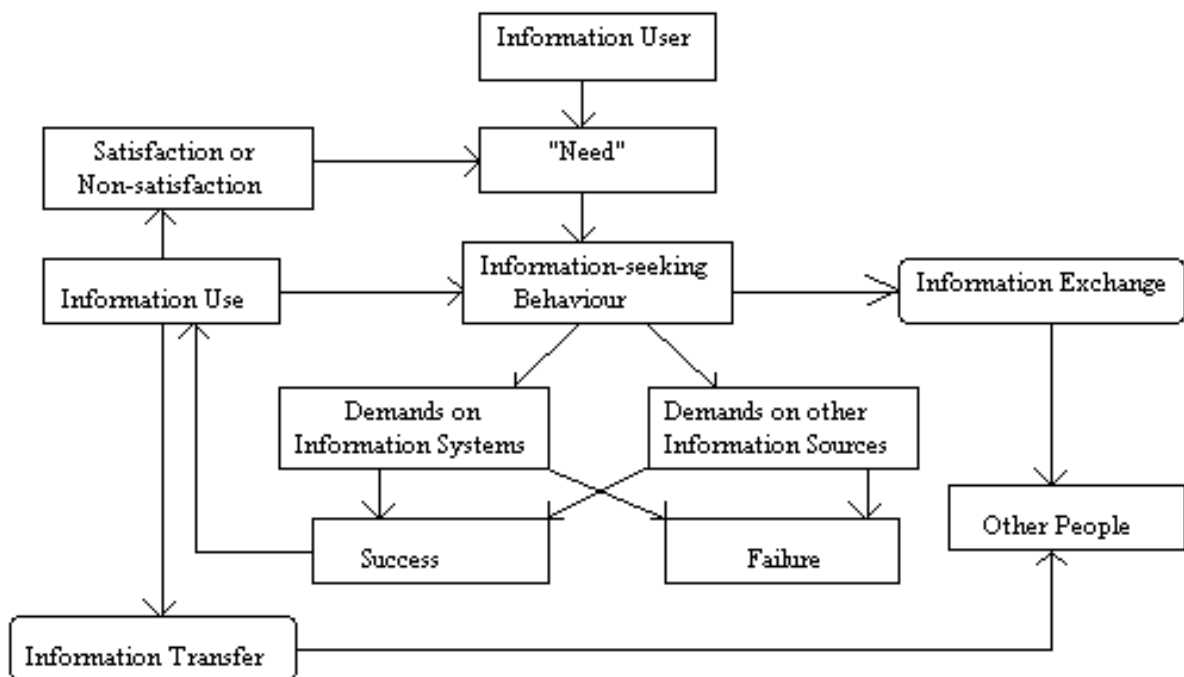


Figure 3. The first Wilson model (Case, 2012, p. 140).

Case (2012) described the first Wilson model along with a myriad of other models; however, one that complements the first Wilson model is the Byström and Järvelin model (1995). This model (see Figure 2) is illustrated as a “feedback loop” (Case, 2012, p. 148), and is based on how personal factors, subjective task, and situational factors influence the information needs analysis. The first Wilson model explained the information exchange or seeking behavior process the Dallas

Makerspace members were participating in when they were seeking answers to a specific problem. It identified where the demand is happening in the process and who is receiving the most stress of the need.

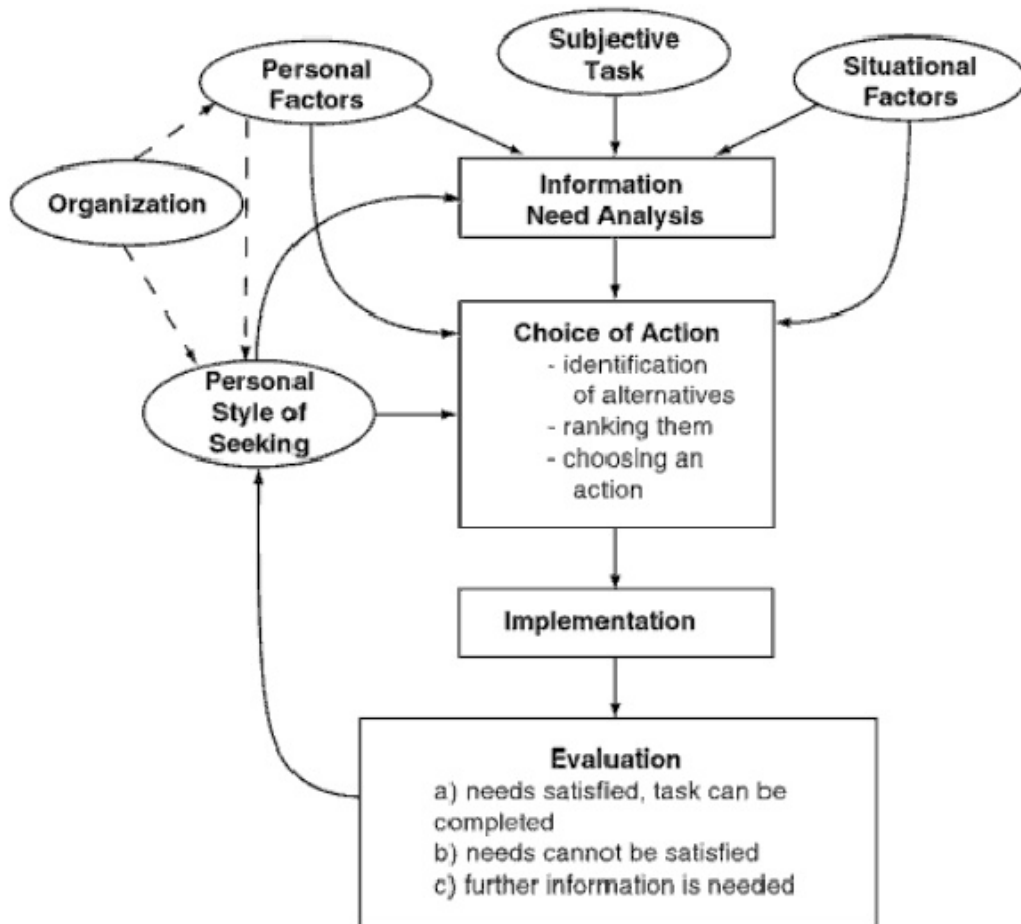


Figure 4. Byström and Järvelin model (Case, 2012, p. 149).

Byström and Järvelin Model

The Byström and Järvelin model has flexibility that allows a researcher to either go through the process of identifying the information needs analysis or deciding immediately on the choice of action the user wants to employ. Once the information user has selected a choice of action, such as identification of alternatives, ranking them

or simply choosing, they move into the implementation phase and then the evaluation phase (Case, 2012). The information user's choice of action is dependent on their personal style of seeking, whether it is exploratory or direct. Both models' information seeking properties lent framework to creating the survey and interview questions (see Appendix A and B).

Guilds

Guilds have a long history, dating back to the founding of towns and villages. Athens, Greece had a thriving market place where people exchanged goods and information about the happenings within the city. According to Bonanni and Parkers (2010), guilds are “characterized by the master-apprentice model, where practitioners devote significant time passing on their skills to the next generation” (p. 180). Guilds exist in our society today in the form of online guilds in online role-playing games, craft guilds, and groups such as boy scouts or girl scouts. These are just a few examples of the thriving nature of guilds in today's society. These groups, along with makerspaces thrive on a formula to build guilds or as Mitchell (2018) refers to it, a “protocol for launching a formal artistic group had been well established: identify [key] members, define an aesthetic philosophy, and—perhaps most importantly—publish a periodical espousing that philosophy” (p. 75). The Dallas Makerspace has those aspects with the members of the space, their mission statement as their aesthetic philosophy, and the online discussion forum, TALK, as their publishing forum. While the members of Dallas Makerspace are important, in this scenario the committee chairs and the board are the key members of the space.

Makerspace conception and practices are built on community information and resource sharing. Now, there is an online component as virtual communities are built, some of which are for everyone like Facebook, and some are for paid members, for example the Dallas Makerspace talk forum. The forum functions as a guild with threads based around each committee. The Dallas Makerspace is comprised of a three-member officer team and 24 different committees. While members can potentially form their own guilds within the facility, the committees and officer team act as guilds. The committees provide feedback to the officers based on the members of each committee, run classes if appropriate for their space, and provide guidance for new members. Each of the committee chairs meet monthly and that is another guild within the space. Part of the study is to determine if these guilds (social networks) are influencing the information exchange. The Dallas Makerspace “provides an environment of co-creation among participants and encourages the collective consumption of this user generated content” (Seraj, 2012, p. 214). The understanding of Dallas Makerspace functioning as a guild brings value to the cultural aspect of the community. According to Ang and Zaphiris (2002) the members have three different ways of contributing to the Dallas Makerspace guild:

Some people contribute to the growth of the community by actively providing help to newcomers, and others by creating a friendly atmosphere and hence a sense of belonging through friendly behavior. Some people, on the other hand, operate at the periphery, enjoying observing the community activities and only engaging in the community activity very rarely, if any (p. 592).

Ethnography

According to LeCompte and Schensul (2010) ethnography is a “systematic

approach to learning about the social and cultural life of communities, institutions, and other settings” (p. 15). Ethnography is the immersion of the researchers into a social setting, in this case the Dallas Makerspace. By immersing in the culture and structure, the users are more open and accessible to the researcher. Using this method helped illustrate a clearer picture of the users’ preferred information sharing techniques by incorporating observations and culture of Dallas Makerspace and addressing the research question of the role of information and sharing resources and the willingness to participate in the maker culture.

For this case study, I was immersed in the culture of the Dallas Makerspace and as Farnell and Graham (1948) state, “informants are not passive participants in the research enterprise but instead become intellectual collaborators who can make substantial theoretical contributions” (p. 418). As a member of the Dallas Makerspace since October 2016, I immersed myself in the culture of making. Ethnography requires active participation, not only from the researcher, but also acceptance by the people of the culture being studied. This method was used to understand the culture of the Dallas Makerspace and add context to the results of the study.

The Dallas Makerspace culture emphasized participation in the rules and bylaws. The culture put into place by the founding members of the Dallas Makerspace in the formation of its rules and policies gave insights into how information moves from one user to another, whether it is through formal or informal methods and enhanced my understanding of how the members of the Dallas Makerspace were identifying when they were lacking information. The use of ethnography in this study included active

participation in the facility by attending classes and mingling on the TALK discussion forum.

Dallas Makerspace has three guiding principles about their organization, but the “why they do it” principle about collaboration is rationale for the ethnographic portion of this study: “At Dallas Makerspace we believe that collaboration is a truly effective form of learning. To that end, our members and volunteers teach classes, hold unique educational events and collaborate on cool projects” (Dallas Makerspace, 2017, webpage).

Sense-Making Methodology

Brenda Dervin’s (2003) sense-making (see Figure 5) applies to makerspaces as a methodology for understanding how information is being sought in collaborative environments. Dervin (2003) describes several different types of information and communication systems, but for the purpose of this study the most applicable one is the actor-defined purpose which is used to get ideas, find direction, acquire skills, connect with others, and to get diverse input (see Figure 5). As Dervin (2003) states: “We are surprised to learn that most information ‘transfer’ occurs informally, between friends and colleagues, where the important collaterals are exchanged- information that means something, that is interpretable, that is culturally relevant” (p. 52). Identifying that the user is searching for an information ‘transfer’ uses the concept of sense-making and will answer the research question about how information seekers pursue information.

Dervin’s sense-making methodology worked in conjunction with the first Wilson model and the Byström and Järvelin model for information seekers, and specifically

addressed if the Dallas Makerspace users were interactive in their information seeking process. This methodology gave credence to the process of information seeking and the active steps they take to identify their need and who can bridge the gap in their data. The first step in a person seeking information is the realization that something is missing from their database (the brain) and then employing a seeking strategy. Information seekers use the concept of sense-making to determine what information they're lacking, and identify how to find the information if it is not readily available. If the information is not readily available and they must go seek it then they are using an active form of seeking information. People employ these strategies without knowing that they are doing them because they have learned them from birth as they go through school and life; they quickly figure out what returns the best results for their styles of learning. This then ties back to the ideas of Kenneth Gergen (1999) and his concepts of constructionism, constructivism, and collectivism being utilized to learn.

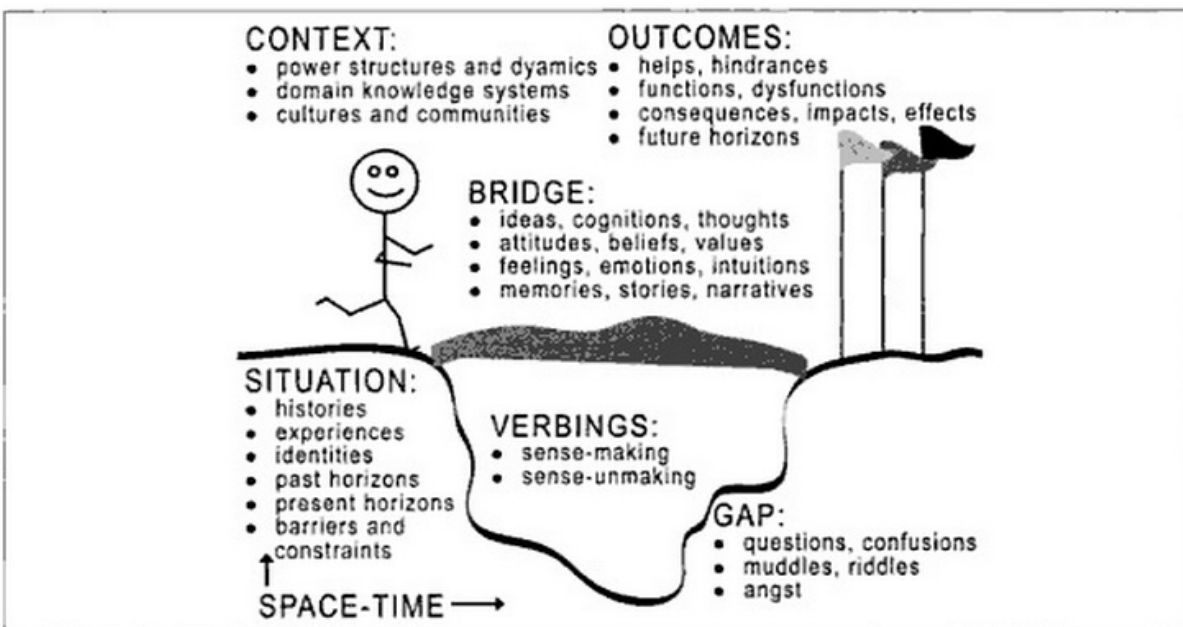


Figure 5. Sense-making methodology (Dervin, 2003, p. 277).

Social Networks

Learning 'Isms'

Depending how learning is accomplished in a makerspace, the learning 'isms' guided the development of the interview and survey questions, and addressed the research question about how information seekers seek and share information and if the means are interactive. To understand the different means by which information is being shared, Kenneth Gergen (1999) defined three different "isms": cognitive constructivism (constructivism), social constructivism (collectivism), and constructionism. Cognitive constructivism lies in the realm of, "individual creation of knowledge structures and mental models through experience and observation" (Talja, Tuominen, & Savolainen, 2005, p. 82). For collectivism, "knowledge is social in origin, the individual lives in a world that is physically, socially, and subjectively constructed; mutual constitution of the individuals' knowledge structures and the socio-cultural environment" (Talja et al., 2005, p. 82). Constructionism is the "production of knowledge in ongoing conversations; knowledge and identities are constructed in discourses that categorise the world and bring phenomena into sight" (Talja et al., 2005, p. 82).

The learning 'isms' are integral to the study because they determined what type of learning is occurring in the Dallas Makerspace. The makers consider themselves as social creators and do not consider what they are learning. Making attracts those with curiosity and ingenuity to be social and innovative in their community. At the Dallas Makerspace there are many different types of groups that meet on a regular basis so those interested parties are collaborating and providing constructive criticism on projects the individual or group is working on.

Table 1

Learning 'Isms' Chart

Meta Theory	Constructivism (Cognitive Constructivism)	Collectivism (Social Constructivism)	Constructionism	
Origin of Knowledge	Individual creation of knowledge structures and mental models through experience and observation	Individual creation of knowledge structures and mental models; influenced by history and social relationships	Knowledge is social in origin; the individual lives in a world that is physically, socially and subjectively constructed; mutual constitution of the individual's knowledge structure and the socio-cultural environment	Production of knowledge in ongoing conversations; knowledge and identities are constructed in discourse that categorize the world and bring phenomena into sight
Philosophical influences	Kelly Piaget	Bruner (early work)	Bruner (later work) Vygotsky	Bakhtin Foucault Garkinkel Gergen Wittgenstein (later work) Volosinov
Representatives	Brooks Todd	Belkin Ingwesen Kuhlthau	Hjorland and Albrechtsen Rosenbaum Taylor	Blair Frohmann Given McKenzie Savolainen Talja Tuominen

Source. Tajla et al., 2004 p. 82.

The learning 'isms' are affected by spatial arrangements of collaborative spaces. Depending on the institution, where the space is hosted and what the makers can do is affected by code regulations and physical space available. Spatial arrangements can create powerful messages depending on how it is perceived by the user (Barniskis, 2016). According to Barniskis (2016) "Creative places share the possible actions and experiences of those using them through policy and practice, including planning and implementation of spatial arrangements. Such socially constructed space is power-laden" (p. 1). This leads to the question of how to create a space that is welcoming and where users do not feel limited in what they can do. The Dallas Makerspace was built by the community for the community and is different from other institutions that house makerspaces such as public libraries, academic libraries, museums, or school libraries. Free standing makerspaces can create a space without the institutional nuances that occur in formal spaces that are required to conform to different rules.

The learning 'isms' guided the development of the interview questions and addressed what the information exchange looks like and gave definition to what type of learning is taking place and how it can be applied in different types of maker environments. The learning 'isms' helps schools understand what type of learning their students are employing, and gives companies insight to the different types of learning accomplished in makerspace and provide different leadership roles. The study recognized the Dallas Makerspace's concept of holistic thinking in environments that are normally one size fits all.

Social Network Analysis

Social network analysis was a key tool for determining information sharing within Dallas Makerspace as a means to find information and how the information seekers are connected to the information providers. It determined if information sharing was mutually exclusive or directional and answered research question two. Social networks are defined as “a way of thinking about social systems that focus our attention on the relationships among entities that make up a system, which we call actor nodes,” (Borgatti, Everett, & Johnson, 2013, p. 1). Modern society led to observations of social networks and how information is exchanged within these groups. One of the key attributes to social networks is facilitating the growth and retention of information. To identify the different types of information flow, Borgatti et al. (2013) described four types of ties: co-occurrences, social relations, interactions and flows.

Table 2

Types of Dyadic Phenomena Commonly Studied

Category	Varieties and Examples
Co-occurrences	Co-membership in groups Co-participation in events Physical distances Similarities in attributes (e.g., political views)
Social relations	Kinship relations Affective relations (e.g., dislikes) Perceptual relations (e.g., knows)
Interactions	Transactions (e.g., 'sells to') Activities (e.g., 'sleeps with')
Flows	Ideas and information Goods Infections

Source. Borgattii, Everett, & Johnson, 2013, p. 31).

The directional flow of information was most central to this study because of the emphasis on ideas and information in a collaborative community. Social exchange theory emphasizes the connections in groups, and makerspaces embrace the “diversity of learning arrangements: individual, facilitated, small group and collaborative” (Sheridan et al., 2014, p. 507).

Social Exchange Theory

Social exchange theory described interactions among members of the Dallas Makerspace as independent, yet contingent on the actions of another, in which information is shared (exchanged) and high quality relationships are developed over time through trust, loyalty and mutual commitment (Cropanzano & Mitchell, 2005). The exchange of information is built on reciprocity and negotiated rules for a beneficial arrangement. The Dallas Makerspace has rules and policies set in place to facilitate the information exchange. There are six different types of resource exchanges: “Love, status, information, money, goods, and services,” (Cropanzano & Mitchell, 2005, p. 18). For the purpose of this study, the focus was on the exchange of information and services. Social exchange relationships are most used when they are mutually beneficial, but they can be directed in one direction, such as a work environment, in which the employee is there to make the company money. However makerspaces are based on a collaborative environment, in which the participants are there to share information and work as a community. While individuals have different motives for using the space, sharing is in the essence of the space. Many join for the love of learning or out of curiosity, but all come with the concept of being productive and innovative in new

and different ways: “Makerspaces are defined by a number of core tenets or qualities: self- directed according to student interest, supportive of curious play and creating with tolerance for failure and retrial” (Oliver, 2016, p. 161). Social exchange theory gives explanation to the information exchange in a makerspace. Identifying what the information flow looks like between those with the information and those without the information they are seeking addressed research question two to create a social map and categorize if the information sharing is directional.

Methodology

This research study used eleven different concepts to form the framework. The information seeking models, the first Wilson model (1999) and Byström and Järvelin model (1995), were used to formulate the survey and interview questions (see Appendix A and Appendix B). Before the formation of the research, survey, and interview questions, I joined the Dallas Makerspace as part of the ethnographical portion of the study. Joining the makerspace, I gained access to the classes and facility and formed a better understanding of the information exchange process. The Dallas Makerspace is considered an informal learning environment; however, the facility hosts standardized classes to use the equipment. The members may propose classes to teach their passion, such as making a fork from wire or Stop Motion 101. Once approved by the site administrator they are listed on the online class schedule.

This study emphasized human-to-human information exchange and the human to information exchange interactions. Interaction is identifying where the information was going and the types of information shared. To understand the human-to-human

information exchange process within Dallas Makerspace, the participants described interactions based on the survey and interview questions to identify the information sharing process and what it is in an informal environment. The human to computer interaction addressed the role of information and sharing of resources on the TALK discussion forum on the Dallas Makerspace webpage. The information behavior models identified how the users of Dallas Makerspaces seek information and if information sharing is directional or mutually exclusive.

Summary

The Dallas Makerspace has three guiding principles that describe the “who, what, and why” of their organization. The organization focused on creating an environment of collaboration between their members and the facility and the public. This study sought to understand the information exchange happening within the facility between the members. The interview and survey questions created for this study relied on multiple information seeking models to understand how users sought information within the Dallas Makerspace facility. The study used principles from social network analysis, learning ‘isms’ and human interaction theory to address different aspects of information seeking and sharing practices. Social network analysis sought to identify the preferred information seeking and information sharing practices of Dallas Makerspace members. Social exchange theory emphasized the perceived value members of the Dallas Makerspace received during the information exchange interactions, from either human-to-human or human to computer. As a Dallas Makerspace member, it gave me the context to implement ethnographic methodology and emphasized the culture of

collaboration and the information exchange between members. Understanding this space's information exchange gave insight to future practices for other makerspaces or informal learning environments not part of formal institutions.

CHAPTER 3

METHODOLOGY

Introduction

This study investigated the information sharing structures among members of a nonprofit makerspace. The researcher sought to establish information sharing preferences of individuals within the makerspace community. The study is an exploratory and descriptive case study of a makerspace using surveys, interviews, and observations to create a fuller picture of the research environment and better contribute to the understanding of the first Wilson model of information behavior and seeking (Case, 2012). The first Wilson model (Case, 2012) demonstrates the cycle that the makerspace users goes through when seeking information in the makerspace. Further data analysis included content analysis and social network analysis to triangulate the data. The study considered the connections of individuals to information based on self-reported information sharing behaviors. Borgatti, Everett, and Freeman (2002) developed a social network analysis software, UCINET©, that was used to create a sociogram of information sharing and information seeking connections among the users of the makerspace.

Participants

The makerspace has an online open forum used to disperse information among the users of the site. To ensure compliance with makerspace rules and regulations, approval was sought from the president of the makerspace to utilize the open forum and

solicit participants. A letter of invitation (see Appendix D) was sent and approved by the president and secretary with details of the members' participation.

The study had a two-part recruitment process for participants. The first part of the recruitment process was a survey (see Appendix A) posted to the online discussion forum three times: once in February 2017, March 2017, and April 2017. The second part of the recruitment for interviews was based on the survey response. Survey participants were asked in Survey Question 15 if they would participate in an interview to gather further information.

The online discussion forum has ongoing discussion postings, such as information about the equipment owned by the makerspace or suggestions of new equipment to buy, class questions, committee notes or interesting trips or information the members have found. Demographic data, such as gender, education level, and age was collected through surveys and interviews as outlined in the research design section. This information was discussed in chapter four. The online discussion forum has several ongoing threads such as a welcome to the makerspace, a show and tell forum, issues and requests, public relations, or meetings for classes and center activities. Based on the current number of postings the show and tell forum is one of the most popular areas of the discussion forum.

Before recruitment for interviews of members of the makerspace, initial access to the makerspace's physical location was obtained by becoming a member of the makerspace. Participants for interviews were recruited from survey responses. During the researcher's interview process, members introduced the researcher to other members who were interviewed for the study. During the observation phase of the

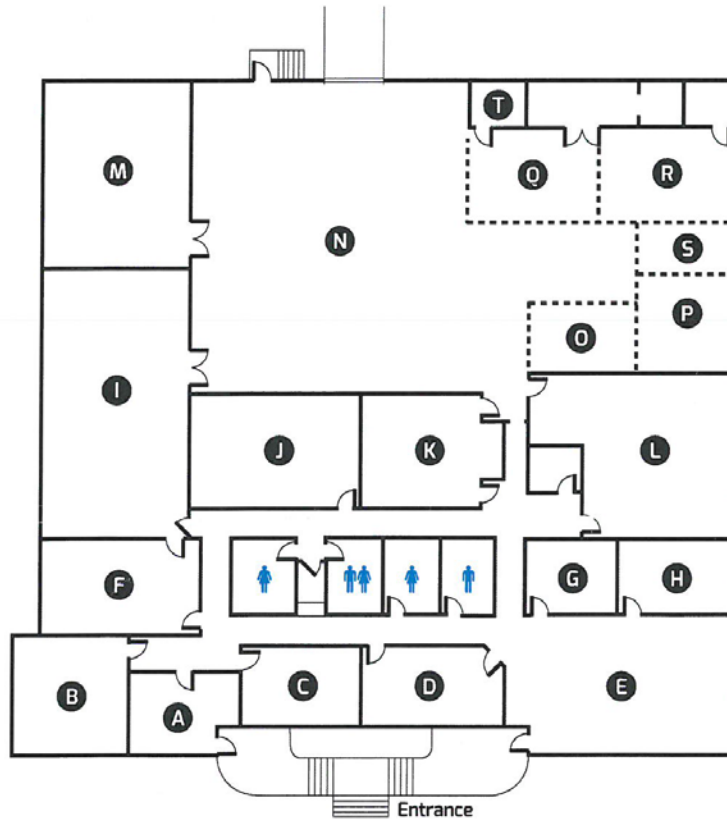
study, the researcher's presence at the physical location provided interest in the study and further participants for interviews. The variety of recruitment methods provided the researcher with insight into the informal nature of information sharing tendencies among the members.

The second part of the recruitment process required contacting those survey participants who indicated their agreement for an interview. The researcher reviewed the survey responses biweekly. Those participants indicating their willingness for further participation were contacted by phone (see Appendix C) or email (see Appendix C) to set interview appointments. All interviews were conducted in person: three in the common area (E), two in the warehouse/automotive area (N), two in the lecture hall (K), one in the jewelry area (S), one in the lobby area (A), and one in the meeting room (G) as illustrated in Figure 6.

Privacy and anonymity are important to participants in research that uses human participants. By using the discussion online forum, which is a public venue, each person was able to register and participate anonymously in the survey. Participants were able to choose their own usernames on the online discussion forum and were not required to share any identifying information with the researcher. Each interview participant was assigned a unique ID number to protect their identities and responses. The interview data, survey data, field notes, observations and other information records were stored in a secure location on a password protected USB flash drive with each of the documents also password protected.



DALLAS MAKERSPACE OPEN HOUSE 2016



MAP KEY

- | | | |
|-------------------------|-------------------------|----------------------|
| A LOBBY | H DIGITAL MEDIA | O SCIENCE |
| B ELECTRONICS | I WOOSHOP | P VECTOR |
| C 3D FABRICATION | J CREATIVE ARTS | Q MACHINE SHOP |
| D TINY PURPLE CLASSROOM | K LECTURE HALL | R FIRED ARTS |
| E COMMON ROOM | L INTERACTIVE CLASSROOM | S JEWELRY |
| F GALLEY | M METAL SHOP | T HATCHER'S WORKSHOP |
| G MEETING ROOM | N WAREHOUSE/AUTOMOTIVE | |

Figure 6. Layout of Dallas Makerspace (Dallas Makerspace, 2017)

Research Design

For the proposed research questions, the most effective way to gather data was a mixed methods approach. The mixed method multi-faceted approach provided qualitative and quantitative data about information sharing and seeking. The mixed method design allowed the researcher to answer each research questions more thoroughly. The different types of information recorded through surveys, observations, and interviews allowed the researcher to fully understand the types of social networks in place at this nonprofit makerspace. Combining social network analysis with observations and interviews allowed the researcher to create a more complete picture of the information sharing process within this makerspace community.

The four stages of research were conducted at the nonprofit makerspace and online through an online discussion forum, an email mailing list, and a Facebook group. The four stages included survey distribution, observations and interviews, survey data analysis, and interview data analysis. Stage one included the distribution of the survey to the email mailing list, a Facebook group, and on the online discussion forum. Stage two included four observations and ten interviews. Stage three was the survey analysis in SPSS, and stage four was the interview analysis using Dedoose©, a coding software. The four stages of research each contributed to answering the research questions as defined in Table 3 below.

The research questions are:

- RQ1. How are information seekers connected with information providers in makerspaces?
- RQ2. What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional?

RQ3. How do information seekers seek information within the makerspace? And to what extent is it interactive?

RQ4. What is the role of information and sharing resources that impact users' choice of participating in a makerspace (physical, archival blog, interviews)?

Table 3

Research Questions and Research Design

Research Stage	Research Questions Answered	How the Research Design is Connected with the Research Questions
Survey Distribution	RQ1, RQ2	<ul style="list-style-type: none"> - Gathered raw data for use to identify common links of connection between information providers and information seekers - Data gathered for directional exchange of information
Observations and Interviews	RQ2, RQ3, RQ4	<ul style="list-style-type: none"> - Gathered raw data for sociograms - Identified interactions between information seekers and providers
Survey Analysis	RQ1, RQ2	<ul style="list-style-type: none"> - Identified data for sociograms - Used SPSS for charting frequency commonalities and case summaries - Used UCINET to create sociograms
Interview Analysis	RQ3, RQ4	<ul style="list-style-type: none"> - Identified learning 'isms' - Determined coding themes - Used UCINET to create sociograms

Data Collection

Stage I Survey Distribution

Stage I evaluated the extent of the connections between the information seekers and the information holders using a survey (see Appendix A). Initially the short survey was completed to gain a preliminary picture of the social networks active within the makerspace, with the goal of 36 surveys (12% of active members), being returned from

makerspace members. The survey was distributed on an online discussion forum, the Facebook group, and through an email mailing list. The survey provided a clearer picture of information sharing and whether it was mutually exclusive or directional. Questions included directional information like “who do you communicate with most often to understand how information is flowing within the makerspace”? Survey participants’ qualitative data was coded to create directed graphs, or digraphs, using UCINET © as part of the qualitative portion of this study and identify networks of information sharing within the makerspace. The blog and online discussion forum was used to mine data to create a cultural picture of the makerspace culture about how the users are interacting within the online discussion forum.

To identify if the information gathered was exclusive to a nonprofit makerspace or not, the survey was also posted on two other makerspace forums. The survey was posted in a Facebook group and once on a makerspace email mailing list asking for participation (see Appendix A). Both forums are public and no identifying information was requested. A goal of 36 responses for survey participation was set. The Facebook group has 176 members while the email mailing list does not disclose the number of users.

Stage II Observations and Interviews

Stage II included four observations and 11 interviews with makerspace members to explore RQ2. Classes are not scheduled in the Common Room, but are scheduled on an as needed basis by committees and individuals. Suggested classes are submitted to a calendar with information about length of time and a preferred date. Classes are held

most often during weeknight evenings and on the weekends because many people work. Some impromptu classes may happen during the week, but those are only posted to the online discussion forum and announced in the room in which it is taking place, i.e. 3D Printer room.

Because of the potential variety for participation interaction, four observations took place in the open workroom, also known as the Common Room (E) in Figure 1. The observations took place: on a Thursday night open house, a weeknight evening, on a Saturday afternoon, and on a weekday afternoon all in the open workroom. These times were chosen for the variety of different classes offered during these times and the different people that would be there. The Thursday night Open House occurs weekly and is an opportunity for people to tour the space to decide if they are interested in joining. Many committees and members are there to demonstrate different machines and skills, such as screen-printing. A weeknight evening had members that arrived after work either to work on personal projects or to attend class or committee meetings. A weekday afternoon was a calm atmosphere since no classes were happening. The Saturday afternoon was bustling with people coming and going and a flurry of activity as people met up to work on projects and attend classes. The observation information was recorded in a field notes journal and reviewed upon completion of the project to check for accuracy and reliability. The observations provided the opportunity to schedule three of the interviews and to better understand the culture and environment of the makerspace; in addition it was an opportunity to interact with members and gather interview participants.

The in person interviews explored the information seeking process with a number of the semi- structured interview questions that addressed how the information seekers look for information. To provide a clear picture of the information exchange within the makerspace, 11 interviews were recorded. The interviews were arranged from six survey participants, one from introduction from an interview participant, and three from members met during the observations as a result of interactions. Once the interviews were recorded and transcribed, the interview data was thematically coded using DeDoose©, an online coding platform.

The interviews were recorded on a sound recording device for audible playback and stored on an external hard drive that will be disposed of after seven years. Participants were identified by a date, time stamp, and a letter assignment (i.e. Participant 1). After the semi- structured interviews were conducted, the interviews were transcribed and reviewed for thematic, inductive coding. Inductive coding is part of the grounded theory approach (citation for Glaser and Strauss) and is used for “(1) identifying categories and concepts that emerge from text; and (2) linking the concepts into substantive and formal theories” (Bernard, 2005, p. 492). Once the transcripts were read, themes were determined by in-vivo coding, or using the actual words from the transcripts to determine themes (Bernard, 2005).

Stage III Survey Analysis

Stage III consisted of analyzing the survey data using SPSS, a statistical software, to determine the trends that emerged from the sample makerspace (See Appendix A). A case summary analysis was run using the age groups to determine the

trends of committee work, relationship definitions and if they knew anyone when they joined.

The second data analysis was a frequency analysis to identify commonalities between gender and relationship definition. The frequency test was also run with age groups to determine commonalities among relationship definitions. The two frequency tests identified if the trends were specific to a gender or an age group.

The survey included qualitative descriptive questions for members to share their preference for seeking and share information. The descriptive responses were assigned ordinal values, 0 or 1, to define the status of the reported relationship. The data was imported into UCINET©, a social network analysis software, that created a sociogram from the survey results. An example of a sociogram is illustrated in Figure 7.

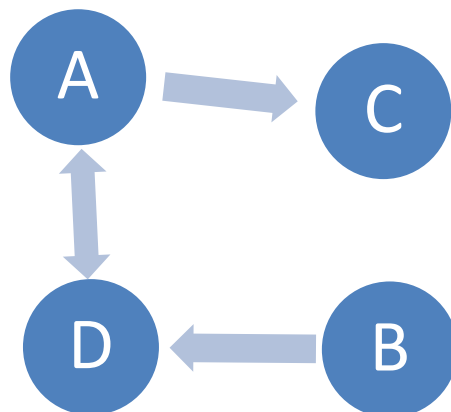


Figure 7. Example of a sociogram.

The directional ties were established using quantitative graph theory developed by Borgatti et al. (2013) that demonstrated social networks statistically. The theory is based on zeroes and ones and exhibits how the individuals are connected by way of the ties between the nodes. Using quantitative graph theory (Borgatti et al., 2013) created a map of the users sharing information in the space and identified how the information providers are connected to the information seekers. It provided the basis for what the

information exchange looks like and if it is directional. An example of this quantitative graph theory is demonstrated in Table 4, as if Participant A shares information with Participant C, and Participant B shares information with Participant D; and Participant A and D share information with each other.

Table 4

An Example of Quantitative Graph Theory

	A	B	C	D
A	0	0	1	1
B	0	0	0	1
C	0	0	0	0
D	1	0	0	0

The survey participants' self reported their information seeking and information sharing behavior. A zero indicated that there is no connection between the participants and a one signified a connection. The social network map identified direct connections between users of the makerspace.

The quantitative survey questions were analyzed for overlapping social networks. Once the analysis was completed and a social map was drawn, it was used to identify the impact of social networks on information sharing. The table identified the different types of interactions happening between users in the nonprofit makerspace.

Stage IV Interview Analysis

The interviews used semi-structured interview questions (see Appendix D) derived from the survey questions. The interviews were conducted at the makerspace in the common room. Within twenty-four hours, the interview was sent to Scribie©, an

online transcribing company, for transcription. The interview questions provided insight into the types of social interactions in the makerspace. The interview participants described interactions such as social relationships with other members, participatory interactions with other members, and the means used to share and seek information within the makerspace. The described interactions helped determine what type of learning 'isms' (Gergen, 1999) were used in the makerspace: constructivism, constructionism, and collectivism. The type of learning 'ism' used within the makerspace provided context to the study and furthered the understanding of information sharing within the community.

The interview questions (see Appendix B) were designed to identify which type of 'ism' the interviewee was using: constructionism, constructivism, or collectivism. The learning 'isms' identified the means that information seekers use to gain information from other sources in the makerspace. This established the directional ties to understand the transfer of information in the makerspace, illustrated by the sociogram. Three 'isms' created a base of influence for the collective information that is being shared within the confines of a collaborative workspace. Ordinal variables were used to assign a numeric value to their relationships in the context of the makerspace. Ordinal variables are "generally exhaustive and mutually exclusive... and can be rank ordered" (Bernard, 2005 or 2006, p. 47).

UCINET®, a social network analysis software, was used to create an information sharing and information seeking sociogram based on Borgatti, Everett, and Freeman's (2002) software. The sociogram is illustrated in *Figure 7*. The sociogram was the result of interview questions: "where do you find information?" and "who have you collaborated

with at the makerspace?”. Two digraphs were created from the information shared in the interviews to give visual representation of the interview details. The ties between the information providers and the information seekers were identified by predetermined categories: information seekers and information providers. The interview participants self reported interactions with different outlets of information sharing and information seeking. The zero means that the example participants self-reported that they did not share information. A one indicates that the example participants self-reported that they did share information with one another. Thematic coding, which emerged from specific outlets in the interviews, determined the outlets, such as classes where the participants were looking for information and sharing information.

Using Dedoose®, the interview information was coded using 6 parent codes, and 26 child codes. The 6 parent codes included: information seeking, information lost, information sharing, how the participants found the makerspace, their job, and the types of projects they worked on. Of the six parent codes, four codes were determined before the coding began and using inductive coding two more were included along with the 26 child codes. In addition to the codes, descriptors were divided into two categories: providers and seekers. A seeker is someone that sought information to work on a project within the makerspace. A provider is someone that provided information within the makerspace. Each descriptor had six fields: method in which the information was sought or provided, frequency, how they learned of the makerspace, type of employment, and projects the participants had worked on.

Gergen's (1999) three 'isms,' were used to establish how of learning occurs and the flow of information from one user to another, or the nodes of the directed graph

above. This was combined with the first Wilson model (Case, 2012) and the Byström and Järvelin model (Case, 2012) to identify how information flows and the type of learning personalities that are most common in makerspaces. Information flow is one of the main identifying characteristics that arises from collaborative work environments. The nonprofit makerspace has one of the largest and most successful non-profit work groups in its size, and the question remains, why?

Limitations and Threats

There were three limitations to this study: the single makerspace being evaluated, the participant-provided information and wording of questions to convey the information sought, and the distribution of the surveys. The limitations of this study are:

1. Only one makerspace was evaluated.
2. Skewed data: the survey posted on the makerspace online TALK discussion forum.
3. Self-reported data by research participants
4. Lack of previous research on the subject
5. Researcher bias

The first limitation could be overcome by evaluating multiple makerspaces in different types of environments to understand if information sharing is mutually exclusive to social networks in multiple types of makerspaces. Only one makerspace was examined because the researcher wanted to understand how the information exchange improved the Dallas Makerspace's continued existence, while other makerspaces in the Dallas area do not have the same longevity.

The second limitation was imposed by where the research had approved consent to post the survey by the President of the Dallas Makerspace. It was posted three times on the online TALK discussion forum. The data restriction could be overcome by handing out paper surveys during classes in the future to reach a larger and different audience rather than limited to those who visit the online discussion forum.

The third limitation was the data was self-reported by the research participants. Another consideration of importance is the timing when the interviews and observations take place in the makerspace. The makerspace is open twenty-four hours a day, seven days a week, and leaves a lot of time for interactions to take place without the researcher being in place to observe it. The information received from participants also may not be enough to adequately answer the research questions. The goal is to offset this limitation with the observations that I conducted as part of the ethnographical part of the study.

The fourth limitation was the lack of previous research on the subject. Between 2006 and 2014 makerspaces increased from 100 to 1400 facilities (Lou & Peek, 2016); however, the research studies only date back to 2014 and there is a lack of studies about the information exchange in informal environments.

The final limitation is my own bias. As a member of the Dallas Makerspace, I have preconceived conceptions of how I think the information exchange is occurring. To combat this bias, I had an inter-coder to validate or question the thematic coding.

Validity

For the purposes of this study, validity was ensured through the triangulation of the research questions, survey questions, and semi-structured interview questions. The

qualitative portion of this study clarified any bias. Member checking was used to verify the results of the survey and interviews, and a peer evaluator was used to clarify the study data and the order in which the results are presented. Negative and discrepant information was included in the findings even though they are against the coding themes set. The quantitative part of this study's validity is based on the surveys returned and developed using a psychometric tool. The survey questions (See Appendix A) are a series of triangulation to ensure the information is unbiased.

Reliability

The reliability for this study resided in the method of delivery for the survey questions through the member forum on the makerspace website and the same questions were sent to all participants in the study. The interviewees were asked the same base questions; however, since it was a semi-structured interview, the questions that come from the comments the participants made were different on an interview to interview basis.

Timeline

For the purpose of this research study a timeline is provided. The timeline is an overview of how the study progressed through the different stages of the research. The timeline has three categories: activity, number or brand, and month completed. The activity category was the 'what' and action taken on the subject. The number or brand section was how many of each activity was completed or the brand name used for the research study. Finally, the month completed was when the activity was finalized.

Table 5

Timeline of Research Study

Activity	Number or Brand	Month Completed
Makerspace Study approval		September 2016
Dissertation proposal and approval		November 2016
IRB approval		February 2017
Surveys	36	February- March 2017
Survey analysis	SPSS Premium Grad pack	March- April 2017
Observations	4	March- April 2017
Interviews	11	March- May 2017
Interview Transcribing	Scribe Online Transcription Services	June 2017
Interview Coding	Intercoder within DeDoose	July- September 2017
Interview Analysis and Conclusions		October 2017
Findings and final write up		November 2017- February 2018
Dissertation defense		March 2018

CHAPTER 4

RESULTS

Introduction

The results of the research study are separated into two sections: survey results and interview results. Social network analysis was applied to both sets of results. Demographic data results were determined using the responses to a survey posted on three online web sites: the makerspace forum, Facebook and the email listserv. Data analysis results were used to categorize responses to RQ1 and RQ2 of this study. Using data analysis tests, including Chi-square, case summary, and frequency on responses to the survey allowed the researcher to determine how information seekers were connected to information providers within Dallas Makerspace and if the information movement was directional or not. Using the participants' responses to questions from the semi-structured interviews, interview results were analyzed to identify commonly occurring themes within the data. The researcher used the identified themes to answer study questions, RQ2, RQ3, and RQ4. Social network analysis was used to understand the information sharing process among the participants. This social network analysis in conjunction with the interview data established the means of information sharing among the participants. Using social network analysis on the survey and interview results allowed the researcher to answer RQ1 and RQ3.

The data collected was used to answer the research questions:

- RQ1. How are information seekers connected with information providers in makerspaces?
- RQ2. What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional?

- RQ3. How do information seekers seek information within the makerspace? And to what extent is it interactive?
- RQ4. What is the role of information and sharing resources that impact user's choice of participating in a makerspace (physical, archival blog, interviews)?

Confidentiality

To preserve anonymity of those participating in this study, all participants were assigned an alphanumeric code and pseudonym. If it was a survey participant a SP and number identified them. If it was an interview participant, an IP and number identified them. All identifying information, including contact information and consent forms were filed on a separate computer from the data in a password protected folder. Subject-identifying electronic data was protected via password while in use and when archived. Additionally, no participant identifying information will be used in any future studies or publications resulting from this study.

Survey Analysis

Survey Demographics

The survey was distributed, using an online discussion forum available to makerspace members; a total of 36 responses ($N = 36$) were received. Of the 36 responders, 28 were male, representing 78% of the respondents and 8 were female, representing 22% of the respondents. The active membership of the makerspace is determined on a monthly basis by the membership coordinator, who estimated the average active monthly membership as 300 members. Thus, the survey response for this study represented 12% of the monthly membership.

Table 6

Ages of Survey Participants

Age Range	18-30	31-45	46-60	60+	No Answer
Number	7	9	9	4	4
Percentage	22%	36%	36%	11%	11%

The age of the participants responding to Survey Question 1 varied widely with a range in age from 18 to older than 60 years of age. For the purposes of this study, the age spread was divided into four categories: 18-30 years of age, 31-45 years of age, 46-60 years of age, and older than 60 years of age. The categories were based on generations and the first category is smaller than the other three because to become a member of Dallas Makerspace the member must be at least 18. Response rates varied among the age groups with the smallest group of respondents belonging to the 60 and older age group. The response rates were as follows: age group, 18-30, 22% ($n = 8$) response rate; age group, 31-45, 31% ($n = 11$) response rate; age group, 46-60, 36% ($n = 13$) response rate; age group, 60 and older, 11% ($n = 4$) response rate. The largest response rate was in the 46-60 age group while the smallest response group was the 60 and older group with an 11% response rate.

Table 7

Educational Level of Survey Participants

Educational Level	Some High School	High School Diploma	Some College	Associate's Degree	Bachelor's Degree	Master's Degree	PhD
Number	0	1	9	1	17	5	3
Percentage	0	3%	25%	3%	47%	14%	8%

The educational level of participants responding to Survey Question 2 varied among survey responses (see Appendix A). A bachelor's degree was held by 47% ($n = 17$) of the survey participants, with 25% ($n = 9$) of the survey participants indicating some college education. Fourteen percent ($n = 5$) of the survey participants indicated they had a master's degree while 8% ($n = 3$) indicated they had obtained a doctorate degree. In response to Survey Question 3, 22% ($n = 8$) were female and 78% ($n = 28$) were male. The distribution of education levels in relation to age and gender is shown in Table 8. All 36 (100%) survey participants were a member of the Dallas Makerspace in response to Survey Question 4.

Table 8

Educational Levels of Survey Participants in Relation to Age and Gender

Highest Level of Education	Age				Total	Gender		Total
	18-30	31-45	46-60	60+		Female	Male	
Some High School	0	0	0	0	0	0	0	0
High School Diploma or GED	1	0	0	0	1	1	0	0
Some College	2	6	1	0	9	2	7	9
Associate's Degree	0	0	0	1	1	1	0	1
Bachelor's Degree	4	5	7	1	17	3	14	17
Master's Degree	0	0	4	1	5	1	4	5
Doctorate	1	0	1	1	3	0	3	3
Total	8	11	13	4	36	8	28	36
Percentages	22%	31%	36%	11%		22%	78%	

Social Network Analysis on Survey Data

The research study began with the distribution of the survey through the online discussion forum to members of the Dallas Makerspace. Participation by members was

voluntary. The survey was posted three times on the online forum, in three successive months, February, March, and April of 2017. Thirty-six members of the Dallas Makerspace responded.

Size and Connectedness

The size of the Dallas makerspace is 1225 members; however on average 300 members are active each month. An active member was defined, by the membership chairman, as a person that attends a class or uses their electronic key to enter the makerspace. The active number of monthly membership is the baseline for the statistics determined within this study. The number of the survey participants is 36 (12%) nodes ($N = 36$).

In response to Survey Question 5 (see Appendix A) about why the survey participants joined the Dallas Makerspace, 67% ($n = 24$) wanted to access the equipment available at the makerspace. Eight (22%) joined to meet people with similar interests and 3% ($n = 1$) joined to learn a new skill. Three (8%) chose not to answer Survey Question 5.

Table 9

Survey Participants Reason for Joining Dallas Makerspace

	Equipment Access	Meet People with Similar Interests	Learn a New Skill	No Answer	Total
Number	24	8	1	3	36
Percentage	67%	22%	3%	8%	100%

Survey Question 6 (see Appendix A) determined if the survey participants knew another member of the Dallas Makerspace when they joined. Twenty (56%) did not know anyone when they joined the community. Nine (25%) did know someone when they joined the community. Seven (19%) elected not to answer this question.

Table 10

Survey Participants Knowing Member at Joining

	Knew a Member	Did Not Know a Member	No Answer	Total
Number	9	20	7	36
Percentage	25%	56%	19%	100%

Survey Question 7 (see Appendix A) asked who the survey participants worked with specifically and there was no overlap in answers. This demonstrated that there is not one member that is the gatekeeper of all information within the Dallas Makerspace. The information is distributed across different members.

Survey Question 8 (see Appendix A) asked about the relationship the survey participants had with other members of the Dallas Makerspace. Fourteen (39%) saw each other regularly at the makerspace, 10 (28%) saw each other sporadically, and 5 (14%) saw each other at the makerspace and outside of the makerspace. Seven (19%) chose not to answer this question.

In response to Survey Question 9 (see Appendix A) about committee participation, 56% (n=20) did participate on a committee at the Dallas Makerspace. Nine (25%) did not participate on a committee and 7 (19%) chose not to answer the question.

Table 11

Survey Participants Relationships to Other Members of Dallas Makerspace

	Regularly Saw One Another	Saw Each Other Sporadically	Saw One Another at Makerspace and Outside	No Answer
Number	14	10	5	7
Percentage	39%	28%	14%	19%

Table 12

Survey Participants' Committee Participation at Dallas Makerspace

Committee Participation	Yes	No	No Answer
Number	20	9	7
Percentage	56%	25%	19%

To answer RQ1, RQ3, and RQ4, the survey participants were asked to define their interactions within the Dallas Makerspace community (see survey questions in Appendix A). Specifically the survey asked the participants to whom they were providing information, where they were seeking information and where they were sharing information. The survey responses to Questions 10 and 11 about information seeking and 12, 13 and 14 about information sharing allowed the researcher to categorize the survey participants' information exchange behaviors and create sociograms showing the relationships between information seekers and information providers. The key listed in Table 13 identifies the categories listed in Table 14, Table 15, and Table 16.

Table 13

Key of Abbreviations for Categories

Abbreviation	Name of Category
3D PR	3D Printer Room
B	Books
C	Classes
CA	Creative Arts
CAS	CA Studio
CC	Committee Chairs
CM	Committee Meetings
CO	Community
DE	Donating Equipment
DMS W	Dallas Makerspace Website
E	Email
EL	Electronics Lab
F	Flyers
FS	Fiber Sig
GH	Google Hangouts
I	Instructors
ID	Individual
IN	Internet
J	Jewelry
MM	Member Meetings
MS	Machine Shop
OC	Online Chats
P	Pottery
R	Reddit
SP	Survey Participant
T	Talk
TU	Tutorials
W	Wiki
WM	Word of Mouth
WR	Writing
WS	Woodshop
YT	YouTube

Information Seeking Behavior in the Dallas Makerspace

To answer RQ3 addressing the information seeking preferences of Dallas Makerspace members, the researcher used Survey Questions 10 and 11 (see Appendix A). Of the 36 survey participants, 22 (61%) preferred to seek information from trusted individuals. Five (14%) elected not to answer Survey Questions 10 or 11. For example, when SP 28 searches for information they speak with “People teaching classes, committee chairs, someone recommended by another member.” Thirteen (36%) stated that they searched for their desired information by posting new threads and commenting on current threads to the TALK discussion forum or searching past posts to the discussion forum for information. For example, SP 36 seeks information from “primarily classes or online, from somebody I know if that fails.” Ten (28%) indicated they sought information by attending classes hosted by the Dallas Makerspace. The survey participants’ indications of their preferred information seeking preferences are display in Table 14.

Table 14

Survey Participants Information Seeking Preferences within the Dallas Makerspace

Categories																
	ID	C	T	E	IN	CM	W	MM	I	WM	GH	F	B	YT	CC	OC
1	1	1	1													
2			1							1						
3		1	1				1									
4	1		1	1												
5	1										1					
6	1	1	1	1										1		

(table continues)

Categories

7	1	1	1													
8	1		1													
9	1		1			1	1									
10																
11			1			1		1								
12	1															
13						1										
14						1										
15	1	1	1								1					
16	1	1														
17	1						1		1							
18											1					
19																
20																
21	1	1														
22	1															
23	1	1	1													
24	1															
25	1		1				1			1					1	
26										1						
27														1		
28													1			
29	1	1													1	
30	1														1	1
31	1															
32																
33																
34	1															
35	1		1													
36	1	1				1										
Total	22	10	13	2	3	3	3	2	2	2	2	1	1	1	3	1

Figure 8 is a sociogram of the information seeking behavior preferences of the survey participants. The red circles represent the 36 survey participants, SP1-SP36, and the blue squares are the locations where each survey participants found the information they were seeking. Note, the largest SP cluster is those seeking information from individuals, by taking classes and searching the TALK discussion forum on the Dallas Makerspace website. For example, SP 27 stated that they seek information from, “people teaching classes, committee chairs, someone recommended by another member.”

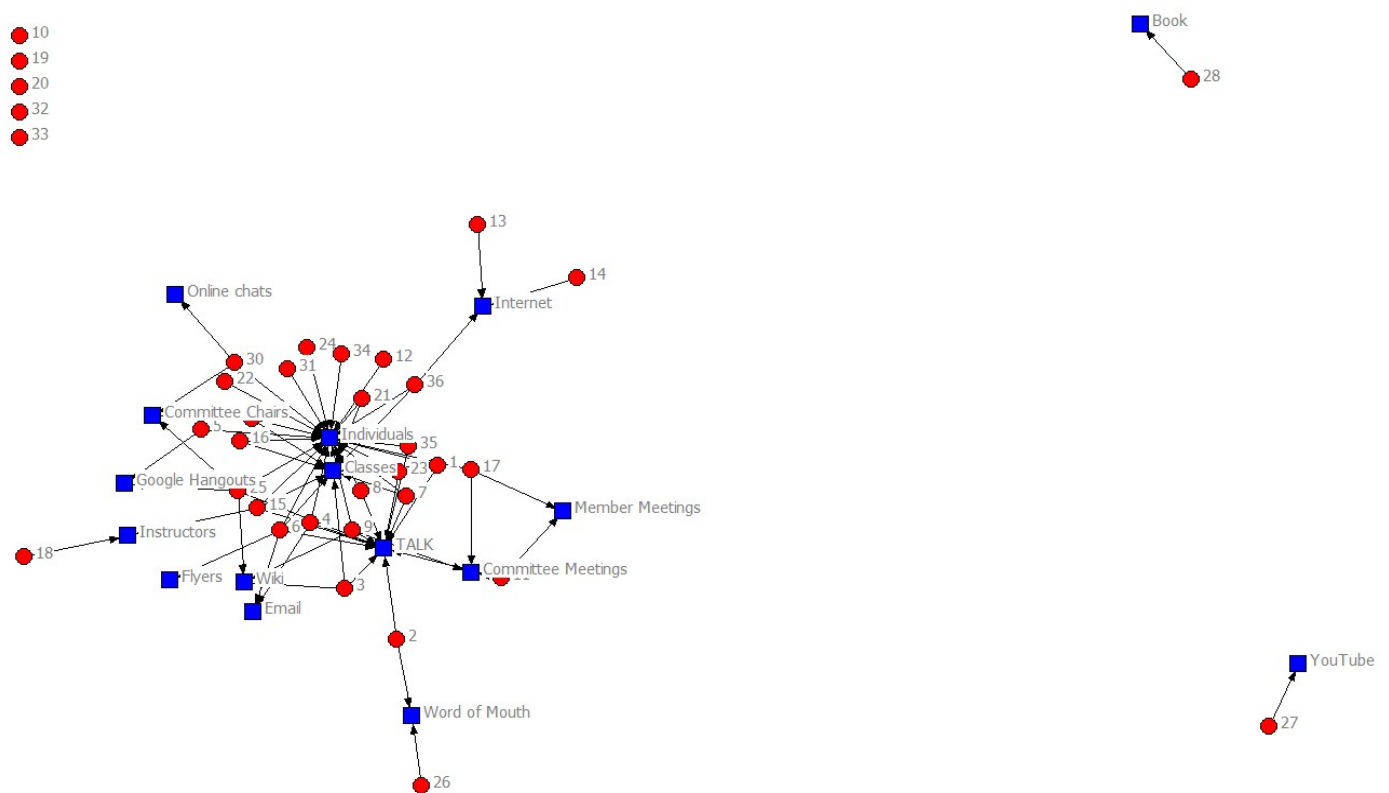


Figure 8. Survey participants Information seeking preferences within the Dallas Makerspace.

During the observation portion of this study, I noted evidence that makerspace members established specific work areas for themselves within the building. The

creative arts room provided cubicles for people to store their work. the machine shop provided a locking cabinet.

YouTube is an open access, video sharing platform providing anything from cat videos to how-to videos. However, only one (3%) survey participant referred to it as their source to find information. Another survey participant (3%) stated that he preferred to seek information by using books only. These participants stated that this was the only way they sought information in relation to the makerspace as seen in Figure 9.



Figure 9. Survey participant using YouTube or book to seek information.

Three (9%) stated that they turned to the Internet to find the information they were searching for. Only one (3%) of the survey participants that used the Internet to seek information also used another source.

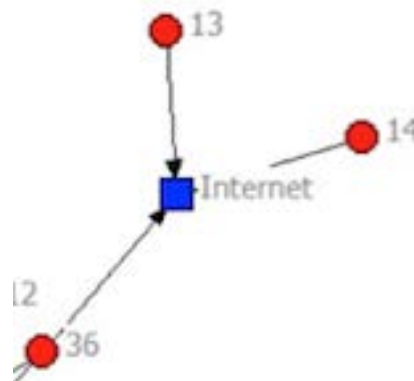


Figure 10. Survey participants seeking information from Internet.

Information Sharing within Dallas Makerspace

To answer RQ1, Survey Questions 12 and 13 (see Appendix A) were examined to determine where information providers were sharing information. Both questions provided for participants to provide detailed answers. The responses were formatted into Table 15. Of the 36 survey participants, 22 (61%) shared information in multiple ways at multiple places, 8 (22%) only shared information when another person asked. Six survey participants (17%) did not provide a response. Table 15 illustrates the locations where information was shared. The survey participants' responses are marked with a tie of 1. Because the survey participants did not indicate the strength of their relationship to the location, all of their ties were ranked as a 1. Survey participants also shared information exclusively in the one area where they were most comfortable: electronics lab, creative arts, pottery, jewelry, woodshop, ca studio, 3d printer room, machine shop, or fiber sig.

Table 15

Survey Participant's Locations of Information Sharing

Categories																
SP	ID	3D PR	C	T	E	IN	CM	CO	CA	FS	EL	MS	CAS	J	WS	P
1	1															
2		1														
3			1													
4			1	1												
5				1												
6	1			1	1											
7	1		1	1												
8	1															

(table continues)

Categories

9										1								
10																		
11	1																	
12	1																	
13										1								
14																		
15	1																	
16																		1
17																		1
18																		1
19																		
20																		
21																		1
22	1																	
23																		1 1
24																		1 1
25																		1 1
26																		1
27																		1
28	1																	
29	1																	
30																		1
31																		1 1
32																		
33																		
34																		
35	1																	1
36	1																	
Total	12	1	9	6	1	1	2	1	2	1	1	1	1	1	1	1	1	1

The sociogram depicted in Figure 11 illustrates how the information is being shared within the Dallas Makerspace community. The sociogram is a visual representation of survey questions 12 and 13 (See Appendix A). The blue squares are the outlets in which the survey participants identified information sharing points. The red circles are the survey participants, 1-36. Six of the survey participants elected not to answer the question and they are the outliers on Figure 11.

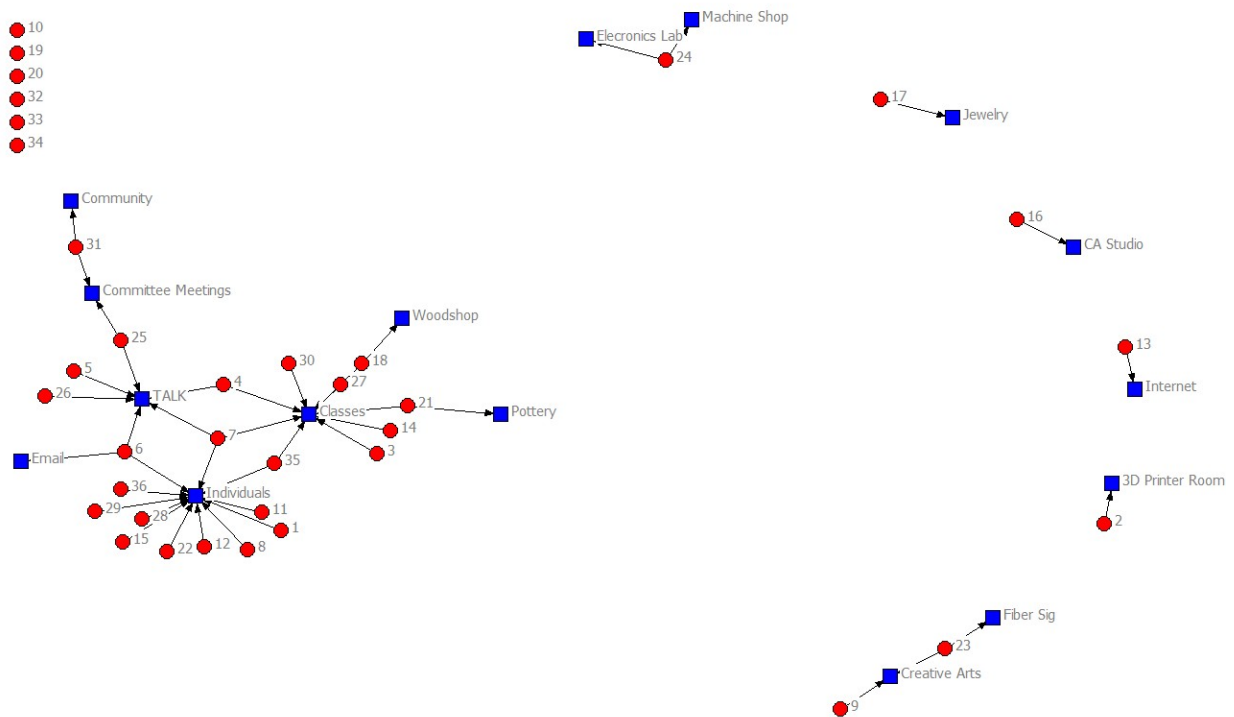


Figure 11. Sociogram of survey participant's information sharing outlets.

Thirty (83%) responded to Survey Questions 12 and 13 and 6 (17%) elected not to answer either question. Of those 30 respondents, 9 (25%) shared information in classes and 6 (17%) provided information on the TALK discussion forum hosted on the Dallas Makerspace website.

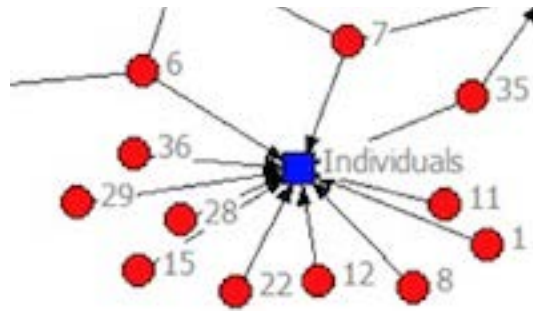


Figure 12. Survey participants sharing information to individuals.

Twelve (33%) survey participants responded that they help individuals. The sociogram is a visual representation of the survey participants sharing information with individuals at the Dallas Makerspace. For example, two participants described how they share information:

SP 12 : Whomever is in the room!"

SP 7: "One is in classes, I teach. Two, many people seek me out because of my manufacturing experience, some advice given on TALK."

The sociogram in Figure 13 is a visual representation of the Dallas Makerspace members that only shared information within their workspaces. Of the 36 participants, seven (19%) stated that they shared information within the spaces they identified with. Only one (3%) shared information with more than one work area.

Information Providers

Survey Question 14 (See Appendix A) was used to answer RQ4 pertaining to the information and sharing resources among users of the Dallas Makerspace; the preferred method for the information providers to share their knowledge.

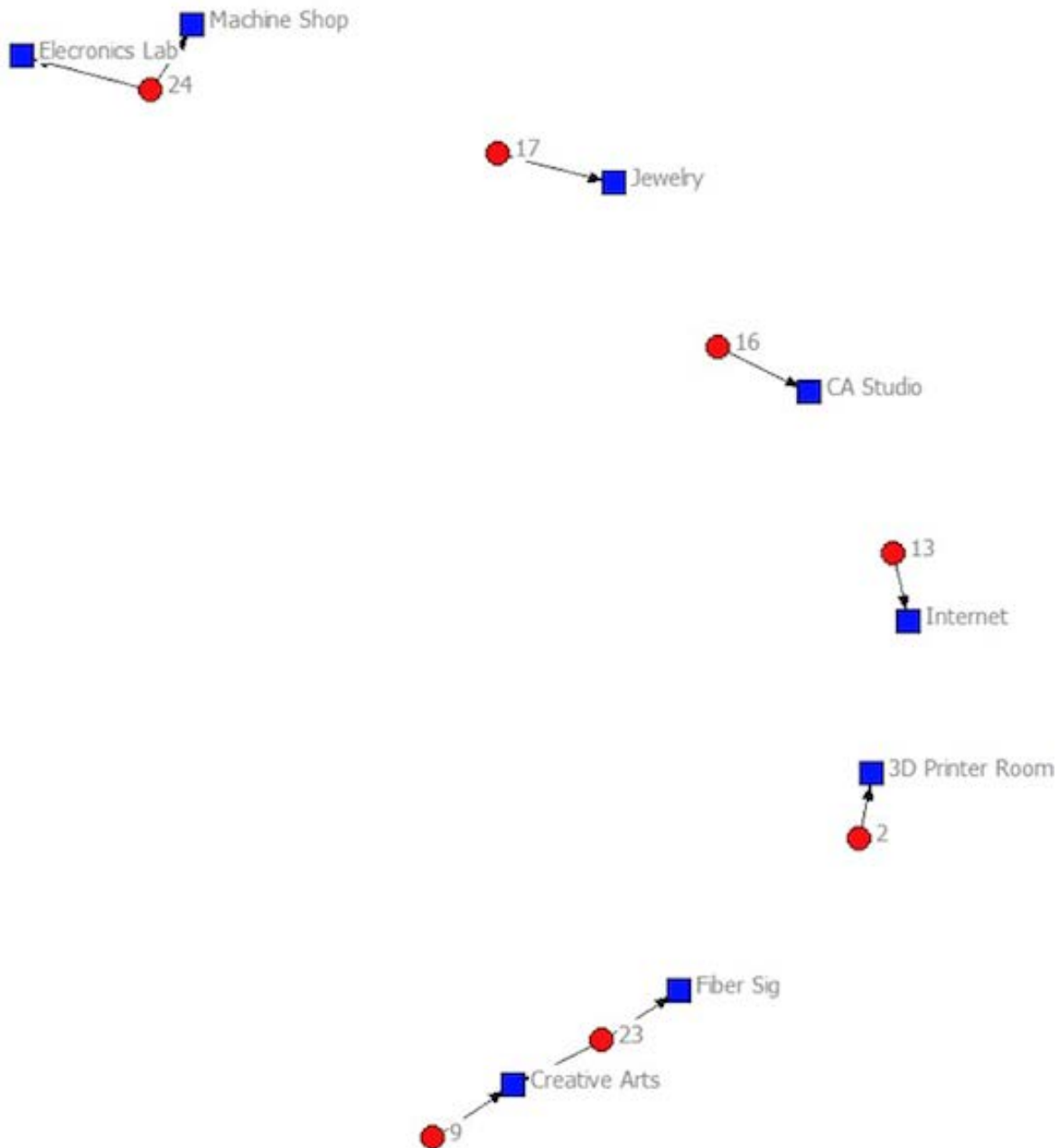


Figure 13. Close up of survey participants sharing information in work areas.

The survey participants preferred to share their information by teaching classes on a regular rotation at the makerspace 55% of the time. The second most popular way to provide resources was one-to-one or on an individual basis 42% of the time. Only two (6%) survey participants chose not to answer this question and 94% of survey

participants were sharing resources and information. Ten survey participants (28%) provided information by word of mouth. Table 16 demonstrates the most popular outlets where survey participants provided information to other members of Dallas Makerspace.

Table 16

Survey Participants Information Providing Preferences within the Dallas Makerspace

Categories																
	ID	C	T	E	IN	DMS W	GH	WM	TU	F	W	WR	DW	CM	R	YT
1		1	1					1	1							
2			1					1								
3		1	1													
4		1	1											1		
5						1	1									
6	1	1	1	1						1						
7	1	1	1												1	
8								1								
9		1	1		1						1					
10								1								
11		1	1					1							1	
12			1				1	1								
13						1									1	1
14		1	1					1								
15	1															
16	1	1														
17	1														1	
18	1	1				1	1					1				
19	1	1	1	1												
20	1	1														
21	1															
22		1	1					1								

(table continues)

23		1							1				1			
24	1		1					1				1			1	
25		1														
26						1										
27	1	1	1													
28	1		1							1						
29	1	1				1										
30		1								1						
31	1	1														
32																
33																
34			1													
35	1	1														
36									1							
Total	15	20	16	2	3	3	4	9	4	1	2	1	1	5	1	1

The sociogram, Figure 14 is an illustration of Survey Question 14. For example, according to SP24, “most of my information goes on Talk. Sometimes I update the wiki, but that is not so often. Then in person gain, for more impromptu things.” Only two survey participants, SP 32 and SP 33, felt that they did not participate in sharing information to other members of the Dallas Makerspace. This lack of sharing is in opposition to the Makerspace culture, which is based on the premise of information sharing (Dallas Makerspace, 2017). Sharing is encouraged through makerspace policy, which waives monthly membership fees if the member teaches two classes (Dallas Makerspace, 2017). The red circles in Figure 14 represent the survey participants and the blue squares represent where the survey participants were providing information to members of Dallas Makerspace.

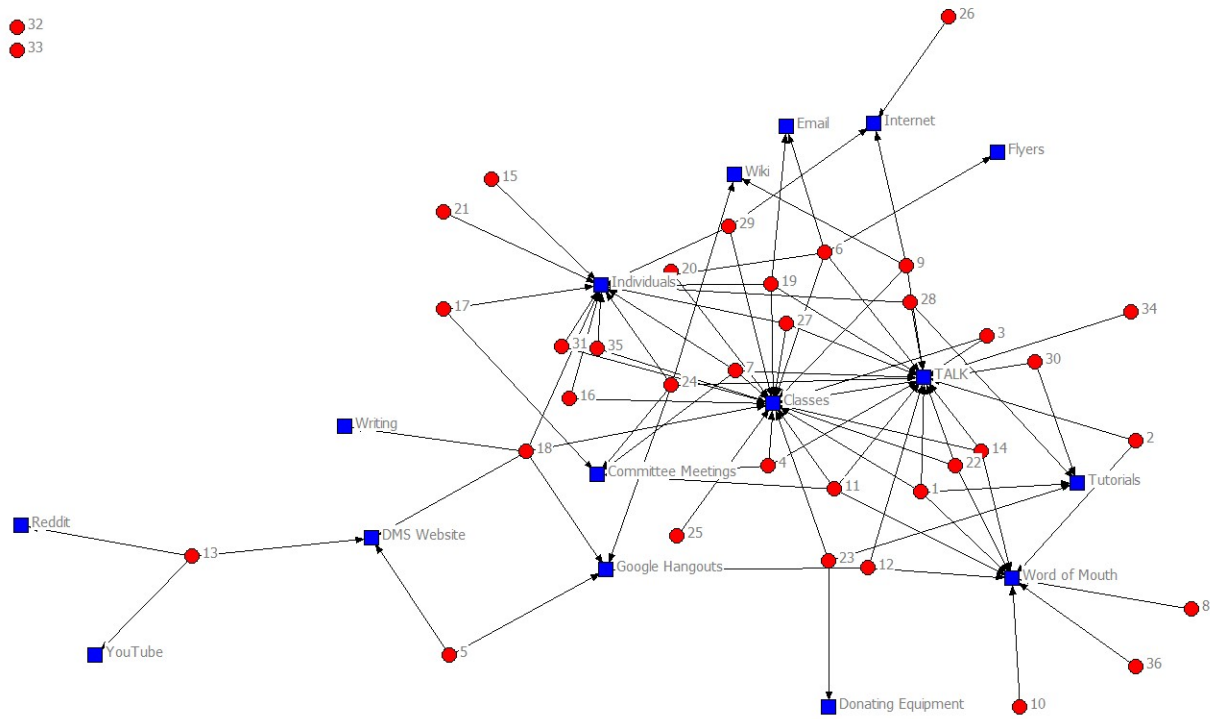


Figure 14. Survey participant's information providing preferences.

Nine (25%) provided information by word of mouth. By sharing information via word of mouth, they are supporting the mission to promote STEM in the community. This demonstrates that they support the concept of collaboration as learning (Dallas Makerspace, 2017).

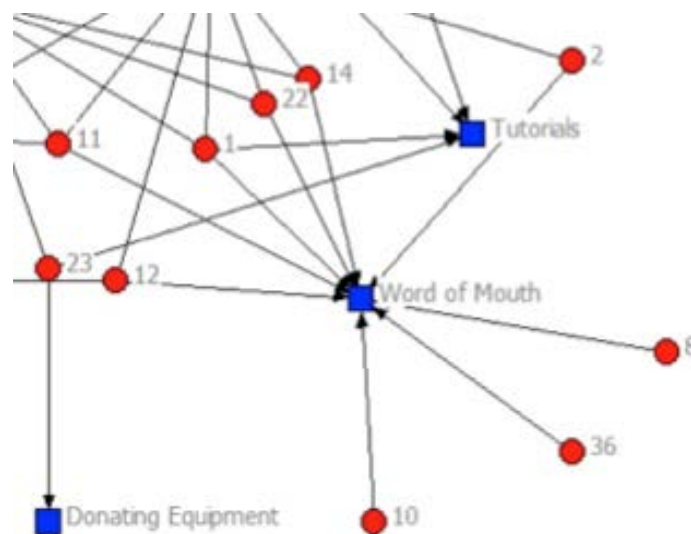


Figure 15. Survey participants providing information via word of mouth.

Members of the Dallas Makerspace are providing information to 16 different areas, but one member only provided information to three outlets that were outliers compared to the rest of the survey participants: Reddit, YouTube, and the Dallas Makerspace Website.

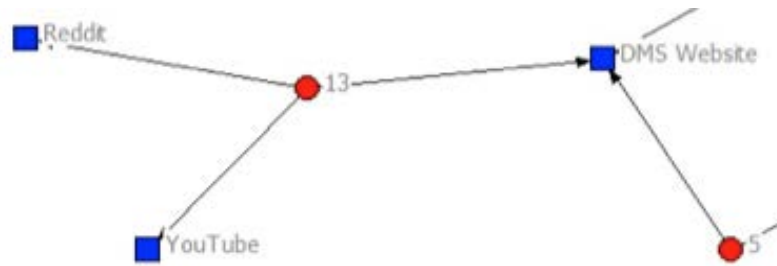


Figure 16. Survey participant providing information to Reddit, YouTube and Dallas Makerspace website.

Cross-Tabs and Chi Square Test

Dallas Makerspace is run by committees and committee work plays a crucial role in its continued success. A cross-tabulation table was used to compare women versus men's participation in committee work at the Dallas Makerspace. Figure 17 used 2 x 2 nominal variables to compare men and women's participation on committees for the makerspace. The table shows the relationship between gender and committee work. The cross-tabs table that was created in SPSS explored the information exchange of RQ2 to determine if information sharing was mutually exclusive. Twenty-three (63%) survey participants participated on committees and proportionately women were more likely to participate on committees.

Table 17

Cross-Tabs of Gender vs. Makerspace Committee Participation

	Female	Male	Total
Participate	6	17	23
Not Participate	2	11	13
Total	8	28	36

A chi-square test was used to determine if a relationship existed between gender and committee participation. The results of the chi-square test are displayed in Table 12 were 0.55 within 1 degree of freedom with a p-value of 0.46. Therefore, the test concluded that there is not a significant difference between the expected frequency and the observed frequency. The research can expect similar results if sampling the full population of the Dallas Makerspace because the makerspace continually has additional members coming in to participate in the community.

Table 18

Relationship between Gender and Committee Participation at Dallas Makerspace

	Participate	Not Participate	Total
Female	6	2	8
Male	17	11	28
Total	23	13	36
Percentage	64%	36%	

Table 19

Chi-Square Test of Gender vs Committee Participation

	Participation	
Gender	Chi- Square	0.55
	Degrees of Freedom	1
	p-value	0.46

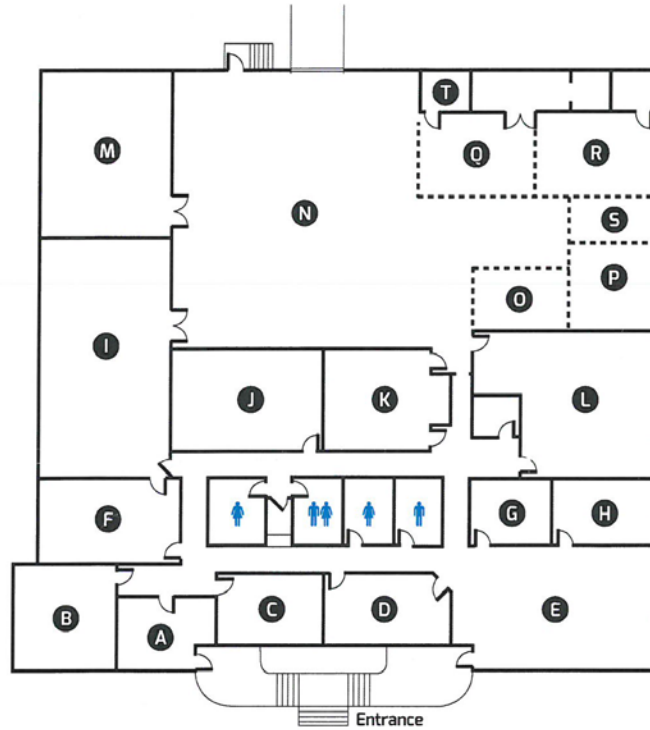
Interview Analysis

As of July 2017, Dallas Makerspace had a membership of 1225. Eleven interviews were conducted in March and May of 2017 using an ethnographic data collection process “to examine one single culture-sharing group with numerous artifacts, interviews, and observations” (Cresswell, 2014, p. 189). Interview participants were assigned a number from 1 to 11 followed by a B, i.e. 8B, allowing them to be distinguished from the survey participants’ responses. Of the 11 interviews conducted, eight (73%) were male participants and three (27%) were female participants.

While the participants were prepared for the interview to last up to 30 minutes, the length of the interviews ranged from 5:10 to 1 hour, and averaged 19:50 for a total of 3 hours and 15 minutes. The interviews were digitally recorded and supported through notes taken during each interview by the researcher. Interviews were transcribed by the online transcription services Scribie. They were edited for clarity to remove the ‘uh’ and ‘um’ for ease of analysis and coding. Three interviews were interrupted due to the interview location and the availability of the interviewee to other members of the makerspace. The interviews that took place in the Common Room and the Automotive/Warehouse area had a few interruptions either because of who the interview participant was in relation to the makerspace and they were needed to help someone with a membership or finance question. Overall the environment was relaxed and the participants enjoyed sharing their knowledge and stories.



DALLAS MAKERSPACE OPEN HOUSE 2016



MAP KEY

- | | | |
|---------------------------|---------------------------|------------------------|
| (A) LOBBY | (H) DIGITAL MEDIA | (O) SCIENCE |
| (B) ELECTRONICS | (I) WOOSHOP | (P) VECTOR |
| (C) 3D FABRICATION | (J) CREATIVE ARTS | (Q) MACHINE SHOP |
| (D) TINY PURPLE CLASSROOM | (K) LECTURE HALL | (R) FIRED ARTS |
| (E) COMMON ROOM | (L) INTERACTIVE CLASSROOM | (S) JEWELRY |
| (F) GALLEY | (M) METAL SHOP | (T) HATCHER'S WORKSHOP |
| (G) MEETING ROOM | (N) WAREHOUSE/AUTOMOTIVE | |

DALLAS MAKERSPACE - 1825 MONETARY LANE, CARROLLTON, TX 75006

DALLASMAKERSPACE.ORG

Figure 17. Dallas Makerspace layout (Dallas Makerspace, 2017).

Each interview was conducted face-to-face at the Dallas Makerspace facility, in different areas of the building (see Figure 17). The interviews took place in the open workroom spaces: three in the common room (E), one in the jewelry area (S), two in the

lecture hall (K), one in the lobby (A), one in the meeting room (G), and two in the warehouse/automotive area. The common room is an open work area with tables that have built in plugs for collaborative or individual work. The jewelry area was a storage unit sized area with lots of cubbies for supplies and a protected area to work with an open flame or soldering iron. The lecture hall was one of their rooms that hold classes and committee meetings. It was set up similar to a tiered classroom with long tables on each of the three tiers and another set at ground level. It had a white board and a desk at the front of the room. The lobby is the first room in the Dallas Makerspace. It contains iPads to pay your membership fees, sign up for classes and check the TALK discussion forum. There are three brown recliners. The meeting room is similar to a conference room with a large table that seats up to 20 people and a TV to project on. The warehouse/automotive area is the largest in the space that is equipped with heavy machinery such as a lift to hoist up cars and extra-large workbenches. It contains a myriad of tools like wrenches, hammers, and car jacks. There is another collaborative work area with extra-large workbenches to work on car engines, large individual projects, or collaborate on group projects.

In response to Interview Question 1 (see Appendix B) the answers were about how the members of Dallas Makerspace learned about the facility. Of the 11 people interviewed, 5 (46%) learned about it from a friend or colleague, 3 (27%) learned about it from the Internet, and 3 (27%) learned about it by attending a Thursday night open house tour. For example, Participant 8B stated,

Yeah, and I was curious about it, and I went to one of their open houses. It was kind of in a very seedy, little neighborhood, but I loved it. It was grungy, and it looked like people have just been on top of each other in there, and just wrestling for space, and I absolutely adored it.

Table 20

Interview Participants Response to Finding Dallas Makerspace

	Friend	Tour	Internet
Number	5	3	3
Percentage	46%	27%	27%

In response to Interview Question 2, (see Appendix B) about project collaboration, 6 (55%) had collaborated on a project with another member of the Dallas Makerspace. For example Participant 3B stated,

A lot of the ones I get involved with tend to be engineering students that are working on stuff, because it's like how to manufacture, "What's this material?" And some ideas on that. One of the guys here, he and another member are building a carbon fiber child seat.

The project collaboration question analysis is in the thematic coding section below as part of information seeking practices by members of the Dallas Makerspace.

In response to Interview Question 3 (see Appendix B) 8 (55%) of the interview participants responded that they have taught classes, contributing an answer to RQ2, What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional? For example, Participant 11B stated:

When I was looking around, I was looking around for a kiln, like you'd go to hire somebody to fire a pottery piece, and I ran across Dallas Makerspace, almost two years ago, and I came up here to visit, looked around, I was like 'I have to be here,' and they explained to me the system, and how much it was a month, and then someone explained to me that if I taught classes, that was a \$50 honorarium. So the regular price is \$50 a month, but if you teach a class, that's \$50 you get and then \$50 goes to whatever committee that you're working under, and I was like 'So y'all would pay me to come to Makerspace? If I taught two classes a month?' Because I've done a lot of things in my life, I've been an artist for many many years, and there's a lot of things I've taught over the years, and so I was like 'That's not a bad deal, at all.'

Of the other three participants, two preferred to simply use the space as a workspace for their careers, one was relatively new to the area and space. A commonality among all of the participants was that most were there at least 4 times a week or every day. This made them approachable and many people stopped to talk to them and ask questions during the interviews, contributing to RQ1, How are information seekers connected with information providers in makerspaces? For example, according to Participant 5a, people approach them when they are working in the jewelry area, “especially Thursdays, when they have the tours. People are very curious, and they're asking what we're doing.” Thursdays are the weekly open house night at Dallas Makerspace. Committees have a spokesperson demo their classes and tools and potential makerspace members are able to try them out and speak with current members.

Thematic Coding

According to Bernard (2005) thematic coding is “explicitly using actual phrases from your text- the words of real people- to name themes, a technique called in vivo coding” (p. 493). The qualitative data analysis software DeDoose was used to provide a collaborative coding environment for the researcher and inter-coder. The researcher used three predetermined parent codes: information sharing, information seeking, and found makerspace, to code the transcripts. Three additional parent themes emerged during the coding process in DeDoose: information lost, job, and types of projects. Furthermore, 24 child codes emerged during the coding process, see Table 21 for all codes and frequency of occurrence.

Table 21

Code Frequency

Parent Code	Child Code	Frequency of Occurrence
Found Dallas Makerspace		15
	Friend	6
	Online	6
	Tour	2
Information Lost		10
Information seeking		23
	Classes	3
	One-to-one	3
	Online	4
	Project Collaboration	12
Information Sharing		48
	Class	11
	One-to-One	11
	Online	6
Career		12
	Artist	4
	Engineer	4
	Sales	1
	Veterinarian	1
Types of Projects		18
	3D Print Lab	6
	Ceramics	1
	Creative Arts	4
	Electronics Lab	3
	Laser Cutter	4
	Machine Shop	1
	Metal Shop	4
	Public Relations	1
	Welding	2
	Woodshop	7

The three predetermined codes were developed from the interview questions (see Appendix B). The “found makerspace” code was used to identify the commonality of where information seekers were finding information about the Dallas Makerspace. Within these three parent codes; subset codes emerged during the team coding process to identify patterns in the transcripts. This included the area of the makerspace which the interview participant was collaborating on a project in.

The three parent themes that emerged during the coding process were information lost, job, and types of projects. This is deductive coding, which is described as content analysis based on the researcher’s hypothesis stated before starting coding (Bernard, 2005). Data collection continued until the themes became saturated or “when gathering fresh data no longer sparks new insights or reveals new properties” (Cresswell, 2014, p. 189). The inter-coder and researcher were in agreement 92% of the time. The researcher and inter-coder resolved the discrepancies by adding the theme “information lost” and “job”. Then both recoded their transcripts with these additional codes see Table 21 for the parent codes, child codes, and the frequency of occurrence.

Social Network Analysis on Interview Data

Two sociograms were created from the content shared by the interview participants to give visual representation of the interview details. The ties between the information providers and the information seekers were identified by predetermined categories and from thematic coding. These ties emerged during the use of key words mentioned during the interviews and identified by the coder and inter-coder. Eight

categories were identified as channels for where interview participants sought information and nine categories were identified as outlets where interview participants shared information and are expressed in Table 22.

Table 22

Interview Participants Information Seeking and Information Sharing Categories

Categories	Information seeking	Information sharing
Classes	9	6
Committees	1	4
Dallas Makerspace Open House tours	1	4
Individuals	9	9
<i>Make Magazine</i>	2	0
Online	2	0
Parents	1	0
Public	0	2
Social Media	0	4

The category “classes” refers to a class hosted at the Dallas Makerspace. Members submit classes for approval to teach which are available to members and nonmembers. A select few classes are restricted to members only due to the nature of the classes, such as those requiring advanced levels of instruction. Committees delved into whether the interviews were on a committee at the Dallas Makerspace and if the interview participants used them to seek or share information.

Dallas Makerspace weekly hosts open house events occurring each Thursday evenings year-round. Additionally, two Saturday open house events are held one occurring in the fall and spring. Three platforms in the social media category are

Facebook, the TALK forum, and the Dallas Makerspace wiki. Online refers to YouTube and Instructables. YouTube is an online platform where people can post videos about video games to cats to instructional content. Instructables is an online platform that has step-by-step instructions.

Information Seeking

To understand RQ2's information sharing or exchange exclusivity clustering was used in response to Interview Question 4. It was determined that it was directional and not mutually exclusive using clustering. Clustering is the condensing of similar data into a manageable group to create a matrix to understand the phenomenon (Miles, Huberman & Saldana, 2014). The only evidence of mutual exclusivity among the interview participants was between IP 5aB and IP 5bB that were interviewed together. For example, according to 5bB, "I'm actually very lucky to have him as a friend, because he's like my mentor with a lot of things. He's just very knowledgeable in so many things, especially woodworking so he helps me out a lot." In response IP 5aB said, "Everything she's doing is different, everything I'm doing is different. I mean all these facilities and we have people that we trust, a circle of friends that we work together. So, people tend to go in these clusters." The clustering for the Dallas Makerspace is demonstrated in Table 23 and illustrated in the sociogram in Figure 18

Interview data pertaining to RQ3 question of how information seeker found information used the code "information seeking" theme was developed and found prevalently within the interview responses. Four child codes of the information seeking parent code were developed. Due to the child codes it was concluded participants

preferred to attend classes or seek out one-on-one help from a trusted source or through word of mouth. For example, IP 7B learned about the Dallas Makerspace from his best friend.

Table 23

Interview Participants Information Seeking Preferences

Interview Participants	Individuals	Public	Classes	Committees	Tours	Make Magazine	Online	Social Media	Parents
1B	1		1		1				
2B	1		1				1		1
3B			1			1	1	1	
4B	1								
5aB	1								
5bB	1	1							
6B	1		1	1					
7B	1	1							
8B		1					1		
9B	1								
11B	1		1	1			1		
Total	9	3	5	2	1	1	4	1	1

This pattern was demonstrated through two recurring themes found in the interviews: information sharing and project collaboration. Project collaboration identified if the interview participants had collaborated with another member of the Dallas Makerspace and what type of project they had collaborated on. For example, IP 6 stated: “And then I in turn helped another guy build another one of the printers for him, and that's how I got started with the 3D printing side of things.” Table 23 contains the results of the interviewees’ responses to Interview Question 5 (see Appendix B). The categories (see Table 22) were defined as follows because while each interview participant mentioned

working with individuals they did not specify individuals and they generalized where they were obtaining information. All 11 of the interview participants sought information from individuals that were named, but none of the individuals named by the interviewees were the same. The interviewees seeking information preferences were ranked as a tie of 1 because there was not a qualifying question of how often they interacted with each subject as demonstrated in the table below. The interviewees seeking information preferences were ranked as a tie of 1 as demonstrated in Table 23.

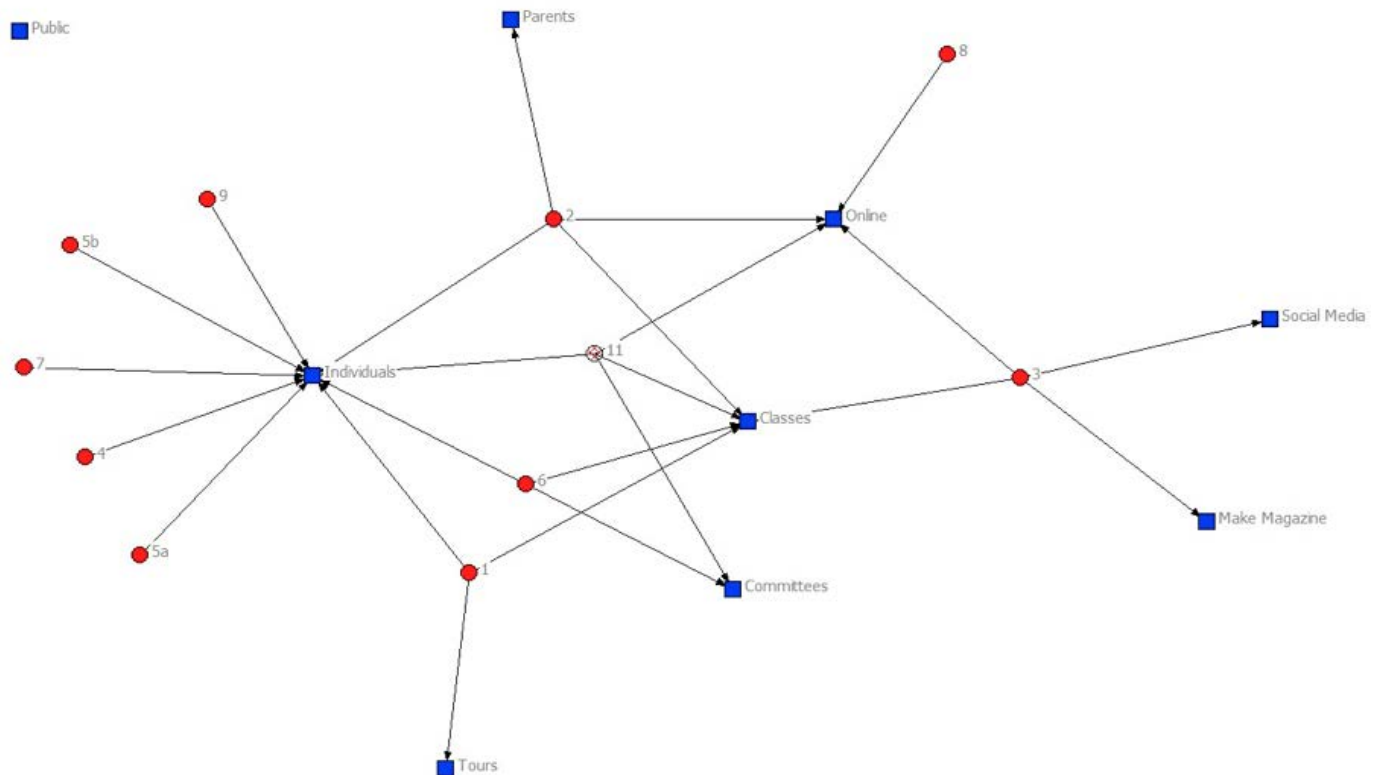


Figure 18. Interview participants seeking information.

Table 23 was imported into UCINET to create a sociogram as seen in Figure 18. The red circles indicate the interview participants and the blue squares indicate where the interview participants were looking for information. The interview participants preferred to find individuals to answer their questions 82% of the time when asked, as

indicated in the table above. Taking classes was the second most popular form of seeking information by interview participants at 45%. For example, according to IP1B,

Mostly I take classes. I've always wanted to learn welding so two weeks ago I took a welding class and I'm still not very good at it, but I need a monitor stand, so I knocked together a SketchUp model of it, in the scrap bin of the metal shop I was able to find the pieces I needed to make it.

IP 4B sought information from Make Magazine and their parents. For example, it was stated, "I have subscribed to Make Magazine since it started, so I have issue 1."

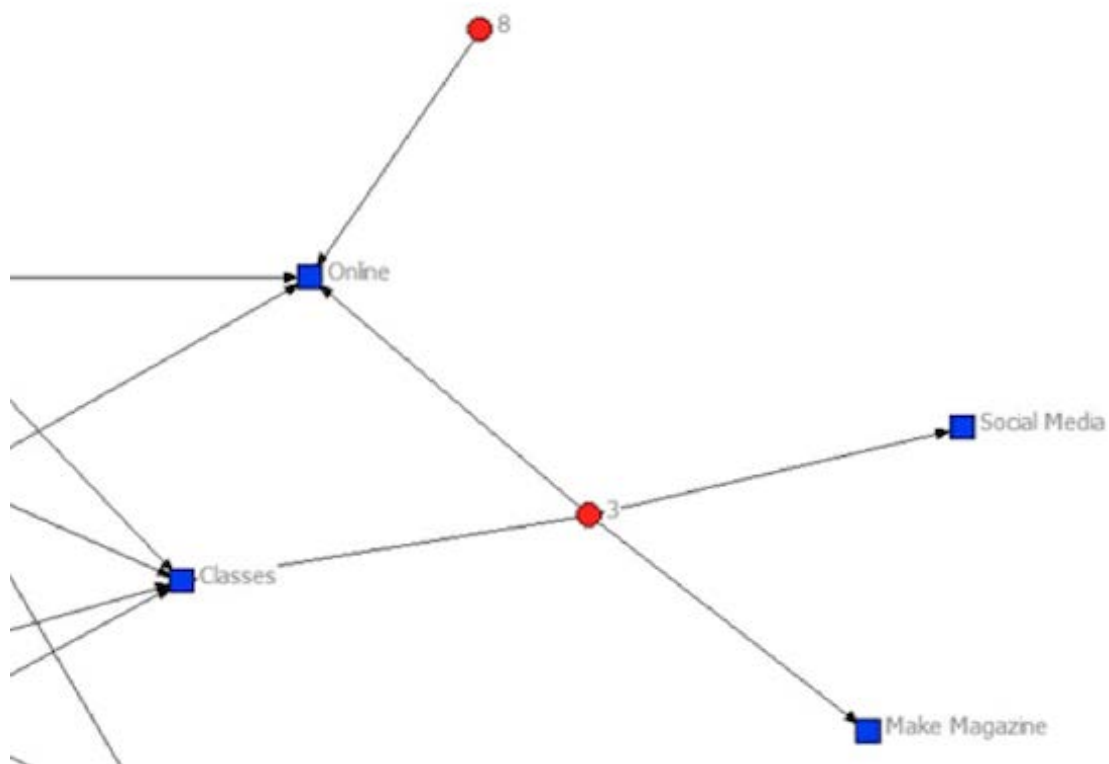


Figure 19. Interview Participants 3B and 8B seeking information.

Interview participants described multiple sources when seeking information online, but YouTube came up twice in interviews. When the interview participants were describing how they sought information,

IP 3B: I have subscribed to Make Magazine since it started, so I have issue one. So I read Make Magazine. I look at Hackaday. There's a guy on YouTube named Jimmy Duresta, I love his videos because they're very well edited. There's

typically no dialogue, so it's just watch and follow, and I invariably pick up a couple of efficiency tips, just from watching the way he works. So it's not necessarily what he's making but how he goes about making it that I find interesting.

IP 8B: YouTube is full of instructional videos, that will teach you how to do everything on the planet.

Information Sharing

Information sharing is a vital part of the structure of the Dallas Makerspace (Dallas Makerspace, 2017). With machines in every space, policy requires that members go through the basic training classes to gain approval to use it at the member's leisure. The data for Table 24 and sociogram (see Figure 20) came from Interview Question 4 (see Appendix B). For example, according to interview participant 11B,

I like one-on-one. I like talking to people. I like finding out what goes on here. I like expressions and nuances and reading. I enjoy teaching classes for the same reason, but I love taking classes and teaching. But we have a Talk forum as well. That's not my favorite.

Nine interview participants prefer sharing information in a one-to-one setting; the Dallas Makerspace weekly open house nights and classes are the largest information sharing points. For example, IP 7B stated,

I give lots of tours, actually. It's a very big knowledge transfer here. Cause when we're talking about the makerspace, especially as chairperson of PR (public relations), my job is to transfer, 'This place is awesome,' to everyone who walks through the door.

The red circles in the sociogram Figure 20 represent the interview participants and the blue squares represent their preferred information sharing outlets. Five (45%) preferred to share only with individuals, rather than in a class or committee setting.

Table 24

Interview Participants Information Sharing Preferences

Interview Participants	Individuals	Public	Classes	Committees	Tours	Make Magazine	Online	Social Media	Parents
1B	1				1				
2B	1		1				1		1
3B			1			1		1	
4B	1								
5aB	1								
5bB	1								
6B	1		1	1					
7B	1		1				1	1	
8B								1	
9B	1								
11B	1		1	1				1	
Total	9	0	5	2	1	1	2	4	1

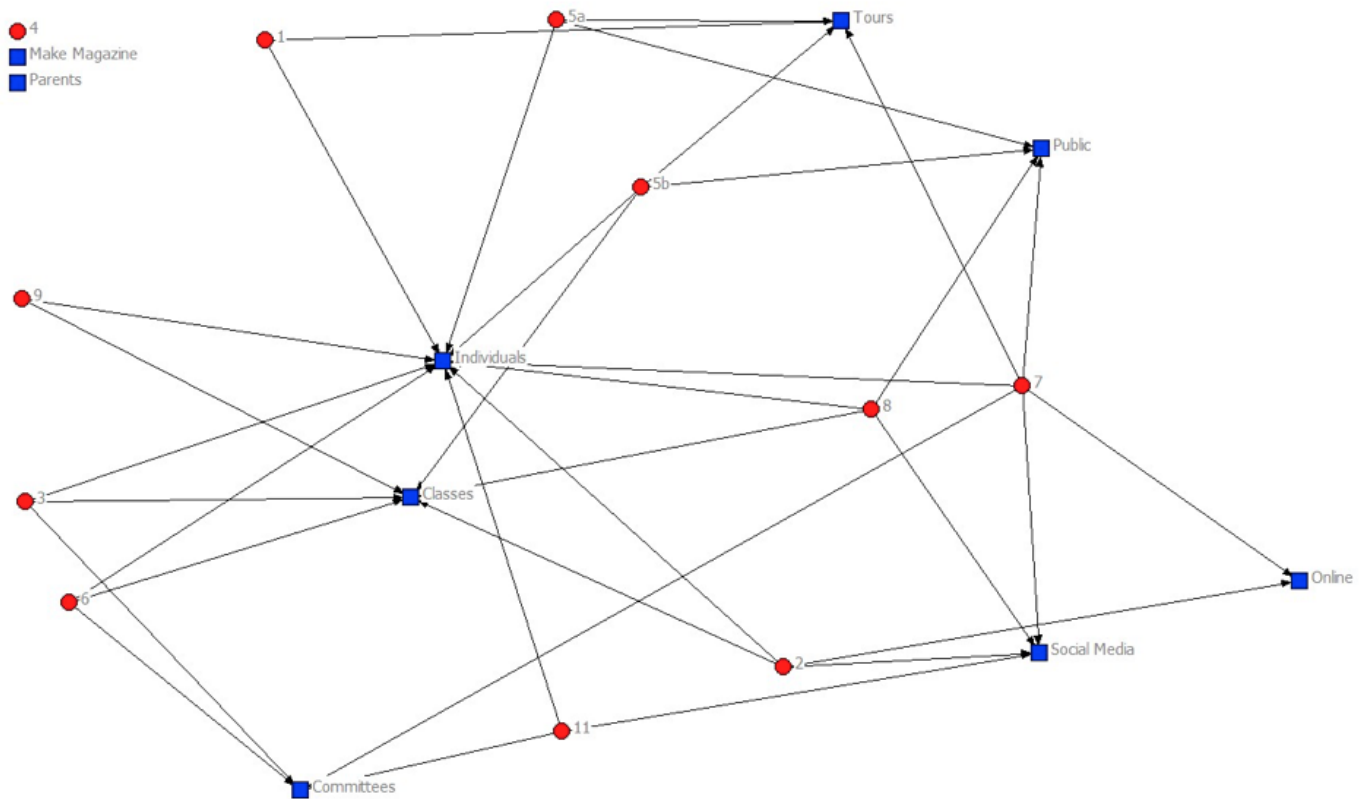


Figure 20. Interview participants sharing information.

Social media is free advertisement and there are multiple platforms to seek information on. Dallas Makerspace board members and committed chairs use Facebook, Instagram, YouTube, and Twitter to share information. When describing how they use social media in the committees, IP 8B stated, “Well, I do Facebook for Creative Arts. I do the Instagram for Creative Arts. I do the Twitter account through Creative Arts.” Four (36%) shared information via social media as shown in Figure 21.

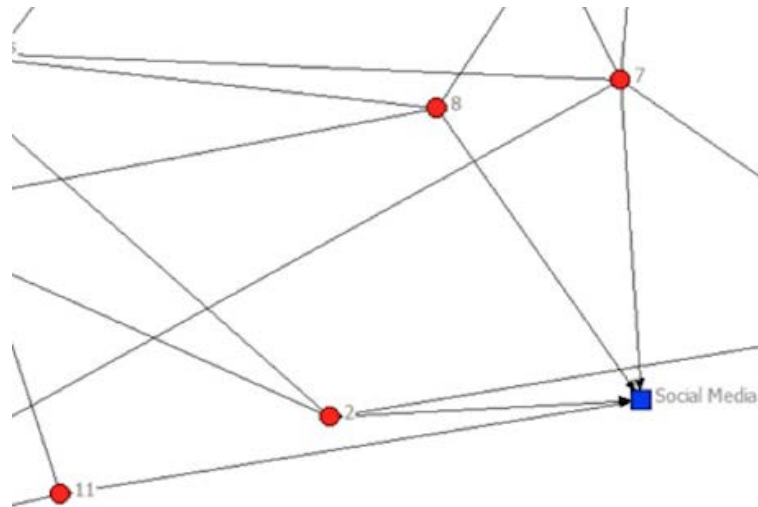


Figure 21. Interview participants sharing information via social media.

Career

The “job” parent code emerged based on interview participants stating whether or not their interest in making and if it influenced their career choice. The emergence of this code also helped answer RQ3 to understand how the interview participants were seeking information within the Dallas Makerspace. This code had four child codes: artist, engineer, sales, and veterinarian. Interview question 6 (see Appendix B) asked the members to share a story of how they became interested in making and for example, IP 8B stated,

Yeah, I think so. I understood paintings as a language at a very early age. I could kinda figure it out and it was enjoyable to do. And then, I eventually wanted to become... I saw Cirque du Soleil. I wanted to be a designer for Cirque du Soleil, and then, couldn't figure out French, and then, had a crisis of heart. And I stared at a sink, and a sink told me that I needed to be an art teacher.

The interview participants' career choice had influence on what committees or areas they participate in at the Dallas Makerspace. The artists worked on Creative Arts committee and the interview participant that works in sales is the Chair of the Public

Relations committee. One of the interview participants that was an engineer before they retired helped out with the electronic lab by donating equipment and mentoring other members. Another engineer preferred to work with the automotive area due to their roots in mechanics. However on interview participant was in a veterinarian. For example, IP 1B, IP 3B, and IP 7B:

IP 1B: I'm a veterinarian and so my field doesn't translate well to this kind of environment.

IP 3B: My background, I'm retired Aerospace Manufacturing, so this is just a natural fit

IP 7B: I sell production equipment for video production companies, television stations, churches, that kind of stuff.

Information Lost

In response to Interview Question 5, one of the codes that emerged during the coding process was "information lost." Seven of the interview participants mentioned it during their interviews. For example, IP 7B stated,

Special interest groups generally fall under a committee. Committees are a lot of dollars, and floor space, and actually, have basically direct access to the board. But what ends up happening sometimes, is that these people realize it's a lot more work than they wanted to put in, and that maybe their committee isn't really taking off. They get two or three people that seem interested, but then those people get busy with life. And then a tool ends up languishing, and then people are like, "Why is this thing still sitting here? Let's get rid of it." There have been problems of... Right now, a current problem, and I'm just giving you examples... A current problem is of the printers. We've got two very large, nice, very wide format printers, but the guy who has been taking care of them, has simply been too busy to get over here and get 'em up at a running. And that has been a issue, because people really liked working with those. It's a lot cheaper than going down to the local print shop. The information does tend to get lost. We do have a Wiki and the Wiki is updated by volunteers. And some people are really good about updating Wikis, and some people are awful. They have no desire to spend their additional time. They wanna just tell somebody, or show somebody, and be able to walk away.

This code was relevant to RQ4 and to understand how resources and information sharing are happening within the Dallas Makerspace community. The machines' continued upkeep is dependent on the members' time and willingness to share with others. For example, another interview participant perceived the information lost concept differently, IP 7B stated:

Hell, most people who leave, leave because they're moving or they got a new job somewhere that's far away or it's too far to get here. The few people who have left who have a lot of knowledge over something always have been very generous with their time and trained somebody else in it. And we try to keep people, not just one person, you know, that's really important to us because there's a \$20,000 HAAS Machine over there, and there's like five people down here who are trained on it fully to teach, let alone the people who are using it. So we make sure that there's nothing that anybody would walk away and say, "Okay, I'm done. I gotta go but you all figure it out." So we're really careful about that.

The different perceptions of how much information is lost are dependent on how involved members are within the Dallas Makerspace. Five of the interview participants participated on committees and their information sharing and transfer is different than a member that does not participate on any committees and uses the space to work on their projects.

Descriptors

According to Dedoose descriptors are “a collection of information that describes the source of your data (e.g., research participants, families, schools, other settings, etc.) at a particular level of analysis” (2017). Two descriptor sets were determined: information seeker (seeker) and information provider (provider).

The information provider set contained six subsets: information, frequency, type of job, method, provider, and project. There were three provider subsets with option lists

and three provider subsets in which text information was input. The text input sets were type of job, project and provider that were identified in the interview transcript about who the participant had provided information for, and if the interview participant was a provider. The first provider subset with an option list was how the participant found the provider of information. The subset had an option list to tag each interview participant from the options list that was found in the coding analysis. The options list includes: Internet, social media, advertising, wandered in, word of mouth, and other. The second provider subset set was frequency where an interview participant shared information with another member of the Dallas Makerspace. The subset contained three options: always, rarely, or sometimes as determined from Interview Question 3 (see Appendix B) and interview participants' responses. For example, IP11B, classified as someone who always shares information with other makerspace users, stated:

I like talking to people. I like finding out what goes on here... What my favorite part is my job, as the president here is connecting people. So what I want to do is bring people together who share a passion.

The last provider descriptor subset determined the method in which the participant shared information: one-to-one, online, or both.

The second descriptor set was seeker. The seeker subset had three option lists and three text information input. The text information input fields were type of job, project, and whether the interview participant was a seeker. The three seeker subsets with option lists were: method of seeking information, frequency of seeking information, and where they sought information. The first seeker subset with an option list is the method used when seeking information: one-to-one, online, or both. The second seeker subset with an option list was the frequency in which the participant sought information:

always, rarely, and sometimes. Figure 14 details the clusters of how the interview participants prefer to find information through individuals or online.

Finally, the last seeker subset with an option list is where the participant sought information: social media, other, Internet, advertising, word of mouth, wandered in or other. For example, according to IP 8B, “I’m a YouTube ho. I absolutely will sit down and suck up YouTube like its mana. I used to be a pretty avid reader. If I really get into an idea, I will research it to death, almost obsessively.”

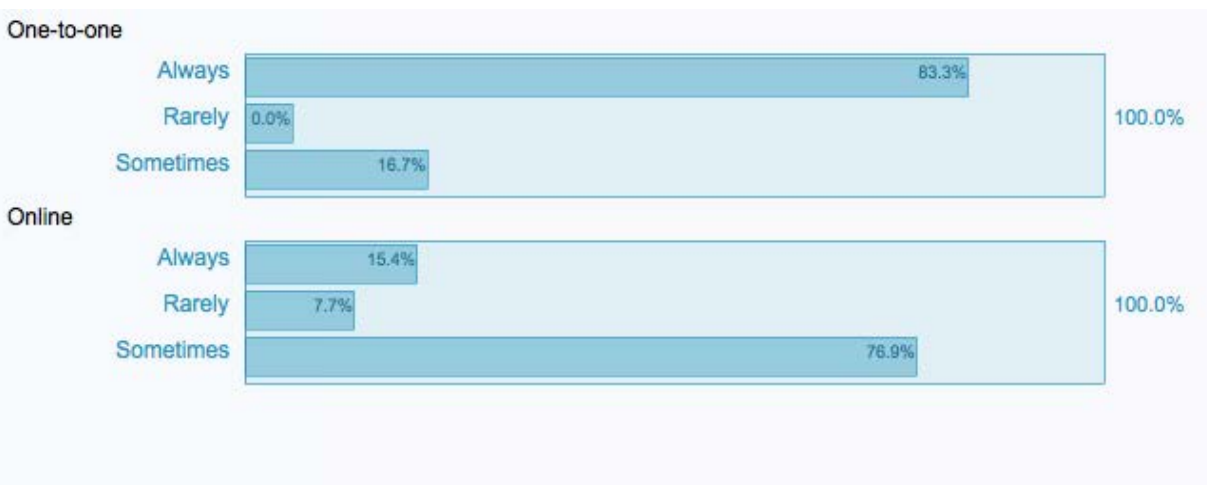


Figure 22. Interview participants information seekers preference of finding information.

The themes developed from interview data analysis and the descriptors identified using DeDoose were pulled into a word cloud. The most frequent phrase in both data analysis was information sharing. This reflects the theme of the Dallas Makerspace website. Information seeking was the second most frequently seen phrase in the data. The figure below showcases the commonality of words found within the interview data. The larger the words, the more they appeared in the interview data. Some surprising themes that emerged during the coding process were job and information lost. Both were significant in answering RQ4 mystery of the role of information sharing and sharing resources in the Dallas Makerspace. Each interview participant referenced his

or her career in relation to using the makerspace. One interview participant, an art teacher, used her skills to chair the creative arts committee for the previous two years. Another interview participant, in sales, was the chair of the Public Relations committee. Both used skills learned from their careers to translate into classes or skills shared within the confines of Dallas Makerspace.

Figure 23 is a word cloud of the descriptor codes from the interview transcripts. These words and themes appeared frequently in the transcripts.

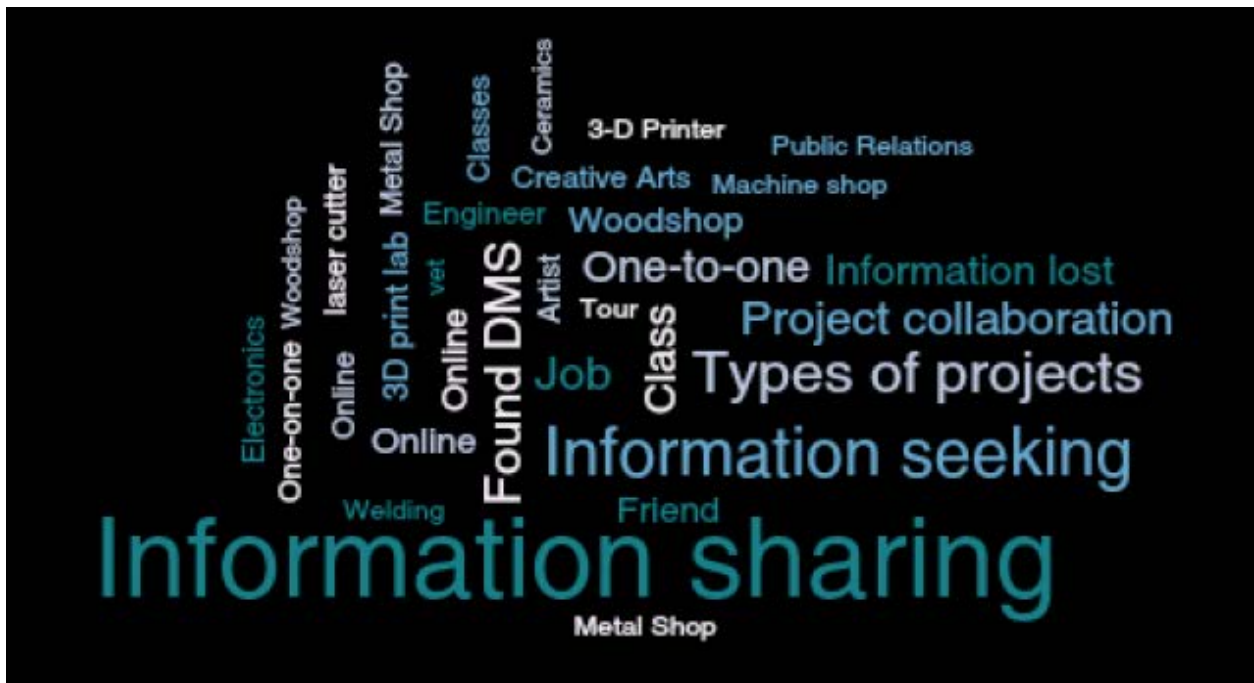


Figure 23. Word cloud of descriptor codes and themes from interview data.

CHAPTER 5

CONCLUSION

Introduction

This interdisciplinary study examined the information sharing and information seeking process using methods of social network analysis and theory and exploratory case study methods in an informal collaborative work environment. While these methods were applied to Dallas Makerspace participants, the methods also apply to any environment that has an information exchange. The makerspace members have the opportunity to connect with others by attending classes, committee meetings, or asking either on the TALK discussion forum or the peer-to-peer. In this study, the guilds are the makerspace as a community, each committee is a guild, and each space, for example the Electronics Lab or 3D Printing room, are each a guild. Members are mentoring others in individual spaces based on their passions or career influence. Careers influenced where individual members chose to “make” within the facility and the peer-to-peer learning that occurs. Peer-to-peer learning and engagement feeds the sense of community, with respect to information sharing and human interaction. The first Wilson model (1999) and the Byström and Järvelin model (1995) of information seeking and the human information interaction theory informed this research study. The first Wilson model and the Byström and Järvelin model guided the formation of the survey and interview questions by addressing how people identify an information need and the process of finding the information. Human information interaction theory describes how relationships influence how people seek information once they identify and information

need. The research questions below directed the investigation of all elements of this study:

- RQ1. How are information seekers connected with information providers in makerspaces?
- RQ2. What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional?
- RQ3. How do information seekers seek information within the makerspace? And to what extent is it interactive?
- RQ4. What is the role of information and sharing resources that impact users' choice of participating in a makerspace (i.e. in the physical space, or with interviews)?

Although the scope of the study limits generalization beyond this particular organization and case, it does provide useful information sharing models for other makerspaces and information collaborative environments. The study offers best practices, insights and theoretical foundation of interaction between information sharing and seeking in a collaborative environment.

- RQ1. How are information seekers connected with information providers in makerspaces?

The Dallas Makerspace is a successfully functioning organization not due to their structure, but as a result of the relationships that have been built within its walls. The members of the Dallas Makerspace are connected by the opportunity to share information with individuals. As shown by the sociogram in Figure 20, nine interview participants preferred to share information with individuals to any other method. This is an example of the strength of weak ties (Granovetter, 1973). The sociograms display some of the outliers in the study: sharing information with the public and exclusively sharing information within their preferred work area in the facility (i.e. 3D Printer Room or Machine Shop). This demonstrates that the research participants preferred not to

share information with outsiders, whether it was not sharing information with people that were not members or outside of their preferred work area.

Social Network Dimension

Social networks are based on actors or nodes that are connected by relationships, which leads to stronger information sharing practices. Granovetter (1973) argued about the strength of weak ties, and how it enhanced the transfer of information among those on the fringes of one network, yet fully entrenched in another. Burt (1992) identified structural holes in organizations where lack of connections between individuals impairs the flow of information, creating a hole in an otherwise connected structure. Social network theory is used for identifying relationships between the nodes and analyzing how the network is functioning.

Social network theory clarifies, to a degree, the success of information sharing structures within Dallas Makerspace as well as the information seeking process. There was evidence of weak ties and structural holes within the Dallas Makerspace; however, those participants were acting as a bridge between groups within the makerspace or outside organizations and persons. To further explore this observation, follow up interviews would need to be conducted and an evaluation of a similar makerspace to identify how the networks continue to function in relation to this point in time. One of the easily identified weak ties is the inconsistency of membership from month to month. The Dallas Makerspace has over 1400 members, but the membership chair estimates that only about 300 are active in any month. Further, committee chairs and board members

agree to at least a one-year term in the position and act as bridges for information sharing to current, new, and potential members of the Dallas Makerspace.

A structural hole in the Dallas Makerspace organization is the class structure. Basic classes that are regularly repeated, like 3D printing and laser cutting, have class outlines so each person teaching the class will cover the same material. However, that is not true for the majority of classes and the ebb and flow of members results in a large amount of information lost. It often requires remaining members to relearn how to use a machine, for example. New technology and machines are purchased at the suggestion of members, but because of the turnover in members much of the technology purchased is not used to its full potential.

This leads to social exchange theory, which argues that the exchange of information and services is based on trust and the development of high quality relationships (Cropanzano & Mitchell, 2005). Based on the reported information there is evidence of social exchange theory. When examining these theories in conjunction with RQ 1 there are a couple of conclusions to note. The members of the Dallas Makerspace are held together by the rules and policies of the space. The connections between members happened for a multitude of reasons, but the most important was the required training needed to operate different machines in the facility. There are three roles: creators, seekers and providers. The creator role is creating or making within the Dallas Makerspace facility. The seeker role is the members that are seeking information to fill a need. A member in this role can attend a class to fill the gap in their knowledge, ask committee members, or ask another member of the space. However, since some equipment requires approval by taking a class, that may be the only option to fill that

information need. The provider role are members who are hosting classes, either the pre-requisite classes to use equipment or one based on an interest, for example printmaking. The pre-requisite classes are required to utilize some equipment in the Dallas Makerspace, such as the laser cutter or 3D printers, and have curriculum created to ensure the same information is taught with all members.

RQ2. What does the information sharing or exchange look like; to what extent is it mutually exclusive or directional?

The information exchange was not mutually exclusive, but it was directional. The survey participants and interview participants did not specify individuals that they were sharing information with, but they did state that it was their preferred method of sharing information. The connection and relationships built within the makerspace enhanced the information sharing or exchange. The members were able to connect with others through classes or the TALK discussion forum. IP 1B used the TALK discussion forum and stated:

There's a post on there about... Someone was talking about 3D modeling a piece of... No, it was a car. They had 3D modeled a car and then Eric posting it was like, "Oh, cool. Wanna do the entire space?" And I was like, "Well, I've always wanted to 3D model this space too," and then we just got together and finally we're able to meet, and then we're gonna meet up in a week or two and just try and finish it off.

This demonstrates the willingness of members to share with other members and it was not dependent on the strength of their relationships. Members connect over shared interests either through class or via the TALK discussion forum. Twenty-five survey participants defined their relationship as either seeing each other sporadically or regularly at the Dallas Makerspace and five participants stated that they saw people at the makerspace and outside of it. The sharing of information is not reliant on the

relationships of the members of the makerspace but rather in the culture of the makerspace as a community of participants.

The Dallas Makerspace is a facility with over 15000 square feet of space and the space is sectioned off into smaller spaces, such as themed work areas (woodshop or automotive) or classrooms. All of the assigned work areas have a committee that teaches classes and mentors new members. Each committee has a wiki page that lists information about the members of the committee, how to join, and available tools for that working area in the Dallas Makerspace. This is a group of people that enjoy learning and sharing what they've learned with others. The Dallas Makerspace members appreciate creating and being around people with similar passions. These are ongoing and life-long learners who want to share their experiences with others by mentoring, one-on-one help, or teaching others in the community.

One of the codes used to determine the information sharing or exchange process was the "information seeking" theme. This theme demonstrated that the interview participants preferred to find information from individuals. The second preferred way of seeking information was to attend classes because so many of the machines require the members to take an introductory class before using a specific machine. For example, IP 8B stated,

I have taken several classes in order to increase my nous [knowledge]. I've taken the HAAS class and the CNC router class, and the plasma cutter class, and the pottery. If it's something that requires a specific tool here that requires training to use, then you usually have to go through the training.

The participants' responses are documented in the survey participants' information seeking sociogram and the interview participants' information seeking sociogram in Chapter 4 (Figure 8 and Figure 18). The rules and policies that require

members to take a class to use certain machines created an information need that facilitates the information exchange that happens during classes.

RQ3. How do information seekers seek information within the makerspace? And to what extent is it interactive?

The Dallas Makerspace members surveyed and interviewed all indicated they were continually seeking information in one form or another and are adept at identifying their information needs. The Dallas Makerspace members' methods of seeking information from trusted individuals and taking a class constitute the two most popular ways for members to find information. The information seekers sought information for three reasons: to find inspiration for a new project, because a skill was lacking or needed to complete a project, or because they needed training to use a machine. Of these 3 information needs, the training required to use machines was regulated by the rules and policies of the Dallas Makerspace.

The information seekers were connected interactively to the information providers via classes, the TALK forum or within the Dallas Makerspace work areas. The interview participants gravitated towards the work areas of their expertise either from their careers or were driven by their passions. For example, one interview participant is a retired electric engineer, who enjoys mentoring community members one-on-one in the electronics lab and in group classes about soldering and circuitry. He also brings in old equipment he no longer uses to donate it to the work space. There was another participant who has served on the creative arts committee for two years, and she shared that her professional role is a high school art teacher. She noted that,

Adult learners are so very different. I teach high school, I teach 11th and 12th grade, and there's a logic to the way you can get into their brain, and you can tell, and we can test, and we can re-test, and I see them every single day. And here,

we're working with an adult brain, which is a very, very, very different nut to crack. It seems to divide up real quick into about four different camps. Some people are gonna be the type of people who get really turned on by an idea, and they're just gonna naturally excel, and teach themselves, but those are the types of people that this place attracts. It also attracts people who think that they already know and those are the dangerous ones. I've done as much as I feel like can... I've sent them home with information and places to find extra information.

These are two examples of how members' career choice is influencing their area of expertise in the makerspace.

Social Network Dimension

Information seekers pattern of seeking information within the makerspace was demonstrated in a sociogram in Figure 8 and Figure 18 and the majority of survey and interview participants preferred to find relevant information by attending classes and speaking with other members. The Dallas Makerspace has created a guild, which is considered "social activity, shaped by communal resources and motivations" (Bonanni & Parks, 2010), with a culture of sharing that is guided by rules and policies put in place by the board of the organization. Within the organization there are smaller guilds in the form of committees and work areas. Using the policies and rules the Dallas Makerspace has created a fluid information transfer.

The concept of guilds explains the outliers in the sociogram of information seeking behavior demonstrated by the survey participants. Bonanni and Parkers (2010) stated that guilds are "characterized by the master-apprentice model, where practitioners devote significant time passing on their skills to the next generation" (p. 180). Each committee functions as a guild with a chair and members to act as mentors to other or newer members of the Dallas Makerspace. One of the three principles of Dallas

Makerspace (2017) is that they “believe that collaboration is a truly effective form of learning” (webpage). Seven of the survey participants sought information from a committee or designated area only. This demonstrates the familiarity that the members feel within their “specialty,” such as Creative Arts or 3D printing.

RQ4. What is the role of information and sharing resources that impact users’ choice of participating in a makerspace (physical, archival blog, interviews)?

The Dallas Makerspace members’ share and exchange information through the design of the founding non-profit members, and the continued success of the organization is guided by the rules and policies that members follow. The rules and policies are emphasized when new members join. The organization has created two ways for members to interact on a regular basis: by participating in classes or by participating on committees. One way to participate in the organization is by attending a class or teaching a class. While the survey and interview participants both agreed that their preferred way to share information and resources was on a one-to-one basis, classes either taught or attended was the second most popular way to share or seek information. This structure of sharing or exchanging information was put into place by the organization. An incentive for members to teach classes is the honorarium. Another way to participate at the Dallas Makerspace is to participate on a committee or create a committee. Committees meet weekly, bi-weekly, or monthly to work on projects or make decisions on how to spend donated money. These three options of participating at the Dallas Makerspace lead to an information theory relevant to RQ3: human information interaction.

The Dallas Makerspace is a system of complex information interaction. According to Albers (2015) one of the distinguishing characteristics of complex human

information interaction is “multiple paths.” There is no single path to an answer. A individual can take many different paths, for example looking for a peer mentor or taking a class, and all will work to fill their information need: The effectiveness of paths may, of course, vary” (p. 6). Another argument Albers (2015) stated that, “complex information communicates concepts and ideas... an understanding of the situation... [and] relationships and interactions” (p. 6). While no member of the Dallas Makerspace described their information sharing practices as a means to find complex information, the research participants described sharing concepts and ideas through many different paths such as, classes and one-on-one tutorials. Classes are peer led by members of the Dallas Makerspace. The members have an understanding of the situation by participating in the Dallas Makerspace and they value the relationships and interactions within the space.

The members of the Dallas Makerspace who were interviewed and surveyed described how they have each built a network of peers who mentor and support them. They understand that the Dallas Makerspace supports collaboration and has created an organized way to build relationships for people with similar interests and passions. For example, Interview Participant 5bB stated, “Everything she's doing is different, everything I'm doing is different. I mean all these faculties, and we have people that we trust, a circle of friends that we work together. So people tend to go in these clusters.”

Emergent Themes

Research Setting

The Dallas Makerspace is a community with a culture of information sharing. To understand the nature and complexity of the makerspace community, I was fully immersed in the organization by attending 2 classes per month, working on projects in the 3D printing lab and customizing coasters on the laser cutter, and participating in makerspace 3D printer committee meetings monthly. Because of the multi-disciplinary nature of the space it is essential to employ interdisciplinary tactics to the research to “promote a richer comprehension that any one perspective provides” (Bates, 2005, p. 4). As a member of the Dallas Makerspace community, I connected with other members and shared information about my study to solicit information and feedback.

Not all members were willing to be interviewed, but they were willing to talk about the history of the space and introduce me to other members who were interested in participating in research interviews. My area of choice that I worked in was the Creative Arts and 3D printing areas and I spoke with several artists who shared information about the structure of committees and the expectations of being part of a committee. Each committee needs at least five members. Committee members are responsible for setting, maintaining, and enforcing the rules of their work area and purchasing equipment for their area. Many committees have come and gone in the space because of the work it takes to maintain them. The committee chair has a vice chair in case of emergency or if they are removed by the board of the Dallas Makerspace. The current ones, such as 3D printing, Robotics and Aerospace, have been around for five years (Dallas Makerspace, 2017).

Information science is interdisciplinary in nature and requires multiple methodologies being applied to the research being conducted in the field (Bates, 1999). Each makerspace has a unique culture and therefore anthropology methods, sense-making and ethnography, are applicable when studying the Dallas Makerspace. This study addressed elements of communication, anthropology, and information science. The research participants are information creators, providers, and seekers. They are stakeholders and organizers of the day-to-day function of the more than 1200 member makerspace. The democratic nature of the makerspace's daily and yearly function has given rise to the exponential growth of membership. Because of the nature of the Dallas Makerspace, it worked well as a research setting with multiple methodological approaches and human information interaction.

Career Influence

One interesting element the coding analysis brought to light in this case study was the influence of the interview participants' daily job. Their chosen profession translated into roles and passions they explored at the Dallas Makerspace. One research participant was in sales and was the chairperson of the Public Relations Committee. One interview participant stated,

Currently, I am the Chairperson of the Public Relations Department. We've been, actually, working on a number of initiatives there, as far as sprucing the space up a little bit. And that's a constant thing, of actually, working on the Makerspace, instead of projects for myself.

Another research participant was a high school art teacher and had created the Creative Arts Committee and been the chairperson for over two years. As part of the Creative Arts Committee she taught classes and mentored. The current chair of the

Creative Arts creates cosplay costumes for a living and mentors members who are interested in cosplay. Originally, one interview participant discovered the makerspace by searching for a kiln, and her work has always worked in tandem with the classes she offered at the Dallas Makerspace and the current avenue of her career. Four participants mentioned having engineering degrees, three shared they had a professional background in art, and one was a veterinarian. All of these jobs tend to have kinetic and tactile aspects within their career role, and this may be what led them to creating and making.

Social Capital

This research study identifies that the Dallas Makerspace community creates social capital through participation theory. The role of making and information sharing is the social capital of the Dallas Makerspace community. Members participate by sharing information through hosting classes themselves and working one-on-one to create a participatory environment. The results highlight that there was not one person who held all of the information within the Dallas Makerspace, but rather many members holding specific information that could be accessed through multiple pathways. Bourdieu (1986) defined social capital as:

The aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition – or in other words, to membership in a group- which provides each of its members with the backing of the collectively-owned capital, a ‘credential’ which entitles them to credit, in the various senses of the word (Bourdieu 1986, webpage).

The social capital is found within the Dallas Makerspace community as its members have an institutionalized set of relationships founded on mutual acquaintance

and recognition of skill sets that are easily accessed through various pathways. Dallas Makerspace members are adding to the organizations' social capital each time they share information by teaching a class or help another member when asked. The value each member is adding during that transaction of interacting is the success and continuation of the Dallas Makerspace.

The information seeking and information sharing behaviors demonstrated by the members of the Dallas Makerspace illustrates their appreciation of socialization, which led to the realization that this is a community of participation. According to Claridge (2004):

Network theories of social capital provide a good starting point for understanding the possible social capital structural changes that result from participation. The majority of participatory methodologies involve social interaction. This interaction results in the formation of weak ties, an important component of social capital (p. 31).

This organization could simply be a space where people come and work on projects; instead it is a community in participation. While the concept of communities in participation has been applied to community development issues, such as health, at the national and the civic responsibility level, this research study is an example of social capital developed at a local level through an individual organization that became a community in participation as a result.

There are two types of communities in participation: interest centered and territorial centered (Claridge, 2004). An interest-centered community in participation is driving by the communities information need, for example a book club, and membership may wan or increase based on the interested persons. A territorial centered community is bound by location and members fluctuate, for example a city. While in many

applications the organization or participants are just one of these types of communities, the Dallas Makerspace is both. The Dallas Makerspace community is territorial-centered (the physical location of the facility) and interest centered (the members). Because of the intentional situation that has been created by this organization, it was an ideal environment to study a community that has a positive relationship with resource management.

The Dallas Makerspace fulfills the three aspects of community that “are most important to those who advocate a positive role for communities in resource management: community as a small spatial unit; as a homogenous social structure; and as shared norms” (Claridge & Agrawal 2004; Gibson 1999, webpage). The Dallas Makerspace community members teach classes about their passions and about the equipment used in their interest area. Some equipment classes have a particular required curriculum mandated for members to complete in advance of using the equipment to ensure information of use and directions for machinery is clearly communicated. However, not all equipment classes have curriculum that everyone can access and these might be reliant on specific instruction from one particular member who holds the knowledge and teaches the class.

This process for instruction could limit the when and how frequently the classes can be offered, and restrict how this knowledge and information can be shared. If a person leaves the Dallas Makerspace community, the information will depart with them. This institutional knowledge will have a gap in this makerspace until another community member contributes. The current board and committee chairs are working on adding an organizational structure, expectations, and sustainable practices common for all

committees to allow for easier transition between leadership, transfer of information, and continual sharing of makerspace knowledge. Ultimately, the study made connections between the members and the place, which demonstrates social capital and community participation theory through specifics of social network analysis and ethnography.

Future Research

The Dallas Makerspace is a large not-for-profit makerspace that functions with volunteers, committees, and a board. The principles of this study can be applied to any formal or informal makerspace. This study provides a foundation to understanding peer-to-peer information exchange, specifically when applied to other informal communities and groups with shared interests. The success of a makerspace relies on social networks and the sharing of information. Social network analysis provided theoretical grounding for the success of communication among individuals and groups within the Dallas Makerspace. Interactions between information providers and users display patterns that have been seen through previous social network research.

Theoretical Implications

There are a number of opportunities for future exploration on different theoretical levels. As the role of informal learning environments and DIY classes continue to evolve and become more mainstream the role of information will play a significant role as well as the information providers' tactics to share information with the information seekers,

and information science theories can provide insights to the success of these programs. Theories such as communities in participation and social capital

Practical Implications

Another aspect to further explore is the utilization of the TALK discussion forum by identifying trends and key concepts. The TALK discussion forum has 31 categories for the contributor to select from. There is 1 topic per space in the Dallas Makerspace and then topics covering information about volunteering, sharing completed projects, general or off topic threads. The TALK discussion forum could poll members on how to involve new members and how members preferences for receiving information about the space. This is also an opportunity to ask how to advertise new members. The Public Relations Committee could do outreach to work force groups or nearby to ensure the sustainability of the facility. Marketing is not simply for external purposes; the same concepts can be used to internally market about new or old tools, such as creating a time-lapse video.

The Dallas Makerspace has started the construction of standardized curriculum, such as 3D printing, but it is not a common practice for all equipment yet. After members take a class to learn about the operation of particular equipment/machine they will then be approved to use it. Additionally, a short reminder guide near the equipment/machine functions as a job-aid to refresh their memory and provide a step-by-step instruction. These pieces of information and knowledge sharing are critical and do not limit how this informs others in the community. For example, one interview participant described a situation where the Hass Laser Cutter lost key individuals who

knew the operation and instructions for use of this machine. One member with the most knowledge of the machine left the community on bad terms, and the community member who supported this work area died, so the equipment and work area within the Dallas Makerspace went unused without information to guide others.

The critical piece for sustaining a volunteer community is organizing the group of volunteers to exchange and sustain information between and among spaces in a centralized or structured fashion. Additionally, there should be some form of leadership succession planning for members of the board and to rotate committee chairs. It might be recommended to have current committee chairs identify and mentor future leaders within a workspace and/or to have a shared leadership role within each committee.

Methodological Implications

Preferably, the research would have included detailed social network analysis of active members' interactions among committees, in classes, and within different areas of the Dallas Makerspace. However this was not within the scope of the study and the software available at the time of the study.

The members had an understanding of the situation by participating in the Dallas Makerspace and they valued the relationships they were building and interactions they had within the space. The result for the Dallas Makerspace is the creation of social capital by participation. This is an area of potential future studies. In the Dallas Makerspace information exchange is based on relationships developed between and by members. It is possible for other communities within this makerspace to evaluate how this information is exchanged by gauging the relationships between members of the

group. The continuation of the Dallas Makerspace community is really the connection to the knowledge offered in each work area and a connection to people with shared interests.

A future area of study for this community would be to examine the gender diversity and overall diversity of this makerspace. During my tenure in the Dallas Makerspace, I observed a lack of diversity. All of my interviews were with Caucasians. More men than women were observed, interviewed and surveyed. Another possible avenue of future study is career influence. Does the member's work influence their career or does their career influence their "making?" This would be possible within each work area at the Dallas Makerspace.

Summary

Dallas Makerspace is one of the largest non-profit work groups in its size, and this research study answers how information is exchanged in an informal environment. The design and utilization of the makerspace creates a level of participation that defines the culture as a community of participation. The social capital created by members of the Dallas Makerspace leads to an investment by the community for the community. Participation is the key to the continuation of this facility and offers ground for interested members to test and retest their ideas. This community highlights the rewarding feeling that people receive by working on a hands-on project. There is something inherently pleasing about saying "I made this!" and the community supports the validation feeling by allowing people to peer-to-peer mentor and share their knowledge. The mission of the Dallas Makerspace (2017) is that "We use these resources to collaborate on

individual and community projects in order to promote science, technology and art; while working and experimenting on innovative ideas to encourage learning within our community.” The Dallas Makerspace is successful because the rules and policies set a framework in place that encourages and supports participation. With the rules and policies, the organization is meeting their stated mission and has created an information sharing and information seeking cycle. The members attend classes for access to machines and members teach classes to waive their monthly membership fee. Through this shared focus on “making” and with a governing structure that emphasizes participation and information sharing, a community of participation is established and maintained.

This research study is an early step in examining the roles of information providers in informal learning environments and the influence their tactics have on the success of the organization, particularly in the makerspace environment. The research results demonstrate that information-seeking models are a vital part to understanding and clarifying the interactions between information seekers and information providers.

APPENDIX A
SURVEY QUESTIONS

1. What is your age range? (select 1)
 - a. 18-30, 31-45, 46-60, 60+
2. What is your gender (select 1)
 - a. Male
 - b. Female
3. What is your highest education level (select 1)
 - a. Some high school, High School Diploma, Some College, Associate's Degree, Bachelor's Degree, Master's Degree, PhD
4. Which makerspace or collaborative community are you an active member in?
5. Why did you join that community/workspace?
6. Did you know anyone when you joined the makerspace/collaborative community?
7. Who have you worked with specifically? (List)
8. How would you define your relationship: 1 (you see each other regularly in the makerspace and outside), 2 (you only see each other at the Dallas Makerspace at regular intervals), or 3 (you see each other sporadically at the Dallas Makerspace and have limited interaction)?
9. Do you participate on any committees?
10. If you are more often seeking information, from whom do you seek it from most often?
11. Do you receive information? How?

12. If you are more often giving information, whom are you sharing it with (someone who asks, knowing someone who is working on a project, or an in-house resource sharing site)?
13. How are you sharing information? Tutorials, word of mouth, websites, classes?
14. Do you provide information? How?
15. Please share a story about how you became interested in making
16. If you are interested in participating in an interview, please share you contact information (email or phone number).

APPENDIX B
INTERVIEW QUESTIONS

1. How did you learn about the makerspace community you participate in?
2. Will you share some information about projects you've collaborated on in the past? What types of projects were they?
3. How do you share information with others in the space?
4. How are you seeking information?
5. How is information retained if someone moves or leaves the group? (Shared drive, etc?)
6. Will you share a story about how you became interested in making?

APPENDIX C
INFORMED CONSENT LETTER

University of North Texas Institutional Review Board

Informed Consent Notice

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: Exploration of information sharing structures within makerspaces: A mixed methods case study of Dallas Makerspace and its users

Student Investigator: Rachel Hoyt, University of North Texas (UNT) Department of Information Science, **Supervising Investigator:** Barbara Schultz-Jones, University of North Texas (UNT) Department of Information Science.

Purpose of the Study: You are being asked to participate in a research study which involves understanding how information is shared in makerspaces and if social networks (friendships) have any influence on how and with whom the information is shared.

Study Procedures: You will be asked to participate in a survey or interview that will take about 15-60 minutes of your time.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: This study is not expected to be of any direct benefit to you, but we hope to learn more about how social network influence on information sharing.

Compensation for Participants: None

Procedures for Maintaining Confidentiality of Research Records: Confidentiality will be maintained to the degree possible given the technology and practices used by the online survey company. Your participation in this online survey involves risks to confidentiality similar to a person's everyday use of the Internet. Interviewees will be assigned a number to protect the individual's information. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study: If you have any questions about the study, you may contact Rachel Hoyt at Rachel.hoyt@unt.edu or Barbara Schultz-Jones at Barbara.schultz-jones@unt.edu.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-4643 with any questions regarding the rights of research subjects.

Research Participants' Rights:

Your participation in the survey confirms that you have read all of the above and that you agree to all of the following:

- Rachel Hoyt has explained the study to you and you have had an opportunity to contact him/her with any questions about the study. You have been informed of the possible benefits and the potential risks of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You understand you may print a copy of this form for your records.

Printed Name of Participant

Signature of Participant

Date

For the Student Investigator or Designee:

I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

APPENDIX D
LETTER OF INVITATION

Consent Form for the Study
Exploration of knowledge creation structures within makerspaces: A mixed methods
case study of the Dallas Makerspace and its users
By Rachel Hoyt, Graduate Student
University of North Texas
In conjunction with
Dr. Barbara Schultz-Jones, advisor
Dissertation Study

I, Robert Davidson, give permission for Rachel Hoyt, a doctoral candidate at the University of North Texas, to recruit, observe, fifty members in connection with her study about their information sharing and social networking in Dallas Makerspace for her dissertation for one year. I understand that all participation will be anonymous, and that any published findings will maintain the anonymity of the school and the participants. I further understand that no student work or comments will be included and the study will focus on teacher instructional strategies and their perceptions of its effectiveness with students.

Robert Davidson

Signature

1-10-17

Date

APPENDIX E

LETTER OF INVITATION TO PARTICIPATE IN INTERVIEW

Hello!

Thank you for volunteering for an interview, I appreciate your time to help me achieve my goal. Are there particular days and times you are at Dallas Makerspace? I will meet you there at the day and time of your preference. If you have multiple times available please list a couple, as to not interfere with any projects you are working on.

Sincerely,

Rachel Hoyt

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