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# Traditionally feminine hobbies and engineering aptitudes

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In the past, there was a widely held belief that women lacked the aptitude for STEM careers, including engineering. Activities traditionally associated with women were perceived as less technical and rigorous than those associated with men. "Masculine" hobbies like woodworking and metalworking were seen as good preparation for engineering. In contrast, traditionally feminine hobbies like sewing, quilting, and knitting were considered preparation for homemaking. However, many traditionally feminine crafts require and develop mathematical knowledge and technical aptitudes, which are essential for success in engineering. This paper explores parallels between traditionally feminine crafts and technical aptitude. By analyzing information from various sources, including books and magazines related to these crafts, we demonstrate how these activities can develop technical aptitudes and explain this in the context of career theory, which is fundamental in comprehending how individuals navigate their professional paths. Childhood, early adult, and later experiences, such as engaging in craft and hobby activities, can significantly impact skill development that carries over into other phases of life. According to career construction theory, individuals actively shape their careers through various self-regulatory competencies. This theory posits that career adaptability, a key competency, can enhance job crafting behaviors, ultimately increasing work engagement. By understanding how these activities can enhance technical aptitudes, the engineering community can better identify and support individuals who may have a natural inclination for engineering, broadening our perception of what engineering aptitude looks like and encouraging individuals from diverse backgrounds, including a greater proportion of women, to pursue engineering careers.

KEYWORDS

**women in engineering, arts and crafts, career theory, hobbies, diversity and inclusion**

## Introduction

Throughout history, many people have wrongly believed that women do not have the skills or interest to pursue careers in engineering and STEM fields. In 1975, a list of misconceptions about women scientists was documented, and one of the most prevalent ideas was that "women are not suitable for scientific careers and are not interested in them" (Sindermann, 1992). This false belief has led to rigid gender roles in both work and leisure activities. Men's hobbies and interests were often linked to their work, and it became an expectation that women who wanted to succeed in STEM careers should pursue the same activities as men.

Knitting, quilting, and, more recently, coding are often seen as distinct domains, but there is a growing recognition in modern times of the interconnectedness between arts and crafts skills and STEM aptitude. Research by LaMore et al. (2013) highlight that individuals with backgrounds in science, technology, engineering, and mathematics (STEM) often possess extensive arts and crafts skills. Moreover, these skills are correlated with producing patentable inventions and fostering entrepreneurship. The study emphasizes that exposure to arts and crafts can enhance innovative abilities, particularly when integrated into lifelong learning experiences.

Many hobbies that are typically associated with women require and improve the same types of skills as hobbies that are generally associated with men. This suggests that someone who pursues these hobbies could potentially excel in STEM fields. However, these connections may not be immediately apparent to individuals, including women, who engage in these hobbies. In this paper, we aim to highlight these connections and propose ways to use this information to encourage more people, especially women, to enter the engineering field.

## Background

Identifying individuals with the right aptitude for a particular career is challenging, but there may be early indications of a person's particular set of skills or interests. However, the way in which childhood interests are linked to skills is influenced by culture and prevailing attitudes. A bulletin from the U.S. Department of Labor in 1954 stated that a child may reveal an engineering aptitude early on by showing an interest in mechanical processes such as building automobile or airplane models, tinkering with radios, and trying to understand how and why mechanical things work the way they do and attempting to make them operate better (Inke and Barber, 1954). The bulletin focused on women, but the assumption was that stereotypically male activities were the best indication of engineering aptitude. There have been attempts to dispel this attitude. A brochure from ABET disputed the fable that women have a tough time keeping up with men students in engineering simply because few girls grow up in an environment where they take lawnmower engines apart or build airplane models (Abet, 1980). It stated that engineering is broad enough that many people don't have this hands-on experience. Further support for the concept that women are involved in mathematics is part of a statement made by Feynman, suggesting that he had anecdotal evidence that women think spatially and utilize more mathematics than credited (Feynman, 1969). Others suggest that "Knitting is Coding," sharing that those who knit code, do math, and often troubleshoot as they perform that craft with projects aligned with this concept in recent years (Ho, 2020). This relationship was analyzed in detail in Craig et al. (2012) n which the specific corresponding elements of knitting and coding were set forth. Recent works provide a justification for equitable gender distribution in fields requiring coding skills.

The researchers found a variety of dated tomes regarding the use of math and math skills in what is often considered traditionally female hobbies. Many of these older sources did not explicitly draw the connection between these skills and the abilities that women have to pursue careers in the traditionally male STEM fields. Upon examination and remaining alert to these discussions that focus on skills or abilities that support hobbies, a surprising number of people recognize the importance of math and spatial skills (Beyer, 1980; Crafts Americana Group, 2003; Berry, 2006a). In a recent interaction with a group of quilters attending a fabric sale, one of this paper's authors stated, "I use math all the time." The following comment was that, "that was a lot of quilting!" Another comment was "I'm an accountant." Finally, one asked what the first one did and the response was "I am an engineering professor." After that the discussion was rather mundane, but the fact is that this group of approximately 42 individuals attending a fabric sale recognized the use of math in quilting. Further, there were at least two of the attendees that work in areas that require the use of a great deal of math. In a similar vein, a relative of one of the authors is a mathematician, and frequently uses her mathematical skills to calculate the fabric requirements for projects.

Refocusing on literature supportive of the connection between arts and crafts and STEM education (Hyllegard et al., 2020), advocate for incorporating "making" activities into STEM learning to engage young learners, especially girls. They suggest that educators can leverage girls' interests to promote STEM engagement by integrating open-ended, experiential, and craft-based activities. This approach aligns with the idea that hands-on experiences in arts and crafts can stimulate interest and proficiency in STEM subjects. Furthermore, the study by Tzanidaki and Reynolds (2011) delves into the meanings of traditional arts and crafts, emphasizing the contribution of these activities to overall well-being. Engaging in arts and crafts is a creative outlet and a cognitive exercise that can enhance cognitive capabilities, including mathematical comprehension. This aligns with (Huotilainen et al., 2018), who suggests that crafts enable individuals to utilize their full cognitive potential, aiding in comprehending complex mathematical concepts. In the context of education, (Pöllänen, 2011) discusses a pedagogical model that combines craft and art education, highlighting the importance of integrating self-expression into craft activities.

By encouraging students to express themselves through their craftwork/handiwork, educators can foster creativity and critical thinking skills, which are essential for success in STEM fields. The synthesis of these studies underscores the valuable relationship between arts and crafts skills and STEM aptitude. Integrating hands-on craft activities into STEM education both formally and informally (Bell et al., 2009) can enhance creativity and innovation and cultivate a deeper understanding of STEM concepts. By recognizing the interconnectedness of arts and crafts with STEM disciplines, educators can nurture well-rounded individuals with the diverse skill sets needed to excel in today's complex and dynamic world.

In addition to these findings, areas such as career theory and spatial and mathematical skills are addressed to further support the positive impact of feminine hobbies on STEM studies and interests.

## Career theory

Aptitude and skills are generally built and reinforced through life's experience (Arthur et al., 1989). Scholars focus on a variety

of theories and frameworks by which to share their research and findings. As the material in the paper was developed through various discussions and findings in very non-traditional ways, the career theory appears to be the best way to provide focus and clear sight through the lens of what supports those going into technical areas – specifically engineering or engineering technology. Career theory provides a way to focus on career development or how one's life unfolds (Arthur et al., 1989). Work since that period provides a greater expanse by defining 5 models and interrelating them; they span interest/career satisfaction to a variety of personal and professional interests (Lent et al., 1994, 2005, 2015, 2016; Lent and Brown, 2019).

This theory provides a framework to analyze current literature and develop various methods to study behavior, references, and ultimately, the choices and activities of individuals related to their career paths. As engineering and engineering technology programs strive to increase diversity among their student body, it is essential to conduct a comprehensive review of existing materials before pursuing further action in this area.

## Spatial and mathematical skills

Considering the development of spatial and mathematical skills in fun pastimes, shows that these skills and abilities can be developed without a great deal of angst. Some may not believe it as one of the issues being researched and found to be endemic throughout STEM fields is math anxiety and the subsequent use of intuition to solve problems. The question then comes to the forefront regarding early hobbies and skills that were acquired. Do they impact the choice of engineering or engineering technology, and further a student/professional's performance in any field?

Considering spatial (Branoff, 2009) and mathematical skills (Ganley and Vasilyeva, 2011) there is a great deal of work done in both areas. The intent is to determine how much a person is driven to a particular field through their abilities and skills developed in the informal environment, where research in all areas is limited (Li et al., 2017). The authors have searched for more work in this area and find that few consider hobbies as a place to find conclusive evidence, or even a hint of what skills provide the impetus to move into a given career, thus providing a broad and intriguing area in which to research, furthering our understanding of how to best recruit non-traditional students into predominantly white, male fields.

## Methods

In this analysis, the researchers gathered excerpts from magazines, catalogs, and pattern books from a variety of different points in time. These publications were all focused on traditionally feminine hobbies such as sewing or quilting.

Other materials used for the study included brochures for engineering as a career, taken from different points in time, and textbooks discussing some of the skills required for various engineering skills. Most of these books and brochures were older materials, dating back to times when women engineers were less common and not as accepted as they currently are.

Further information indicating how arts and crafts can intersect with STEM education was found in various academic publications. These articles spanned a wide variety of different publication venues, including both journal and conference publications. Summaries of the articles found in periodic and informal sources and then formal peer-reviewed sources culminate in this work.

## Findings

Assessing several different types of skills were highlighted in the textbooks and career brochures that were consulted. Some of them could best be classified as general technical skills, which include math and science. Drafting skills have been specifically called out in several sources, not limited to texts specifically for drafting courses, and programming skills have been highlighted more recently. Examples of these general categories of skills are given here.

### General technical skills

While different fields of engineering draw on different types of skills, there has long been a consensus that skills needed for success in engineering include proficiency in math and science. Other skills that are noted as being important, dating as far back as 1948, are mechanical aptitude and spatial visualization. Miller (1948) Later information provided to prospective engineers has continued to emphasize math and science, with the specific other items highlighted varying depending on the source of information and the audience. The need for creativity is also highlighted at times; as one pamphlet states, "Engineering is a creative profession – creativity is the art of taking a fresh look at old knowledge to find practical solutions to human problems." Society of Engineers (1982) Another pamphlet from the U. S. Department of Labor indicated that engineering would be a good career for a girl with "an analytical mind; curiosity; ability to visualize SIZE, FORM, and FUNCTION; aptitude for math and science," and indicated that boys "have no monopoly on engineering talent" (US Department of Labor, 1971).

### Drafting skills

Drafting skills have been important for engineers, particularly mechanical engineers, for quite some time. Drafting, or more broadly engineering graphics, has been seen as foundational by many educators. One textbook describes engineering graphics as "a cornerstone of engineering," and indicates that the ability "to describe an idea with a sketch is a prerequisite of the engineering profession." Eide (1985) In addition to the inclusion of drafting classes in the typical mechanical engineering curriculum, other topics draw on drafting skills. In the textbook *Basic Graphical Kinematics* (Kepler, 1960), it is stated that "Graphical kinematic analysis can be at least as accurate as analytical analysis in which

a slide rule is used." The book further discusses the importance of scaling in the context of a discussion of engineers' and architects' scales, and how important the ability to scale a drawing up or down is.

## Programming skills

Programming skills are also acknowledged as important to engineers in many different fields, as well as those who are specifically studying computer science. Typical texts on programming, even going back to the early days of computer programming, present some of the same type of basic information on coding. As an example, a text on FORTRAN programming discusses the types of statements and the order of execution, presenting statements that instruct the computer to do something and those that alter the "flow of control of statement execution," which allows for programs in which "groups of statements can be executed repeatedly" (McCracken, 1965). Similarly, the importance of understanding algorithms is emphasized in a text on ALGOL (McCracken, 1962) Similar skills are still important in programming, although languages have changed over time, with some new languages created and older ones falling into disuse. More recent resources include these same types of structures, and emphasize the importance of algorithms.

## Hobbies

While there are many hobbies that may be seen as traditionally feminine, a small subset of these hobbies is highlighted here. They all have enduring popularity, although they have seen fluctuations over time, and are widely associated with women. Furthermore, there are significant publications in existence that can be consulted to gain information on them. They are quilting, sewing, and knitting and crochet.

## Quilting

Several links were found between quilting and skills that are used in engineering, primarily through drafting and geometry, and these links go back quite some time. In *Quilter's Album of Blocks and Borders* (Beyer, 1980), the quilter Jinny Beyer indicated that prior to the 1890's, few quilt designs were even named, nor were patterns given - merely pictures - indicating that "women knew how to draft, cut out, and piece the patterns." Furthermore, she quotes an 1860 issue of Godey's Lady's Book as saying about patchwork that "The only care which it exacts is a mathematical precision in the foundation shapes of which it is composed, and a knowledge of the laws of colors", clearly indicating that this type of mathematics is something that women are expected to know.

Drafting skills are typically assumed to be necessary for many different quilts shown in women's magazines. As an example, in the magazine Family Circle (Maple Leaf, 1977), a pattern is given for a "Maple Leaf Quilt from Scraps." This pattern includes a small drawing of the requisite maple leaf with a square grid (Image in Appendix, Supplementary Figure 1). Readers were instructed to use the grid to re-draw the shape at the proper size, indicating that scaling drawings up and down was a common and expected skill.

More recently, in the quilting catalog Connecting Threads (Crafts Americana Group, 2003), the quilt designer Nancy Mahoney was quoted as describing herself as "a math person" and stating that "The geometry and precision of it draws me to design" (Image in Appendix, Supplementary Figure 2). Further links between quilting and engineering skills are seen by those pursuing both. An article in Quilter's Newsletter Magazine, "My Other Job Is. . ." (Berry, 2006a), indicated that many quilters have professional careers in STEM and business fields. Women profiled in the article included physicians, architects, scientists, and engineers in various industries, many of whom indicated that there were parallels between their quilting hobby and their professions.

## Sewing

While quilting does involve sewing, there are other aspects of sewing that show parallels to technical fields such as engineering, as was observed by E. A. Johnson and K. Miyanishi of the University of Calgary and the University of Guelph, respectively, who discussed this in a letter to American Scientist magazine (Johnson and Miyanishi, 1999) that responded to a previous article by the author Henry Petroski (Image in Appendix, Supplementary Figure 3). These professors indicate that "the abstract conceptualization, planning and actual construction skills so useful later in science and engineering need not only be developed in 'boys' activities."' and specifically mentioned sewing clothing. They went on to state that " sewing requires proficiency in planning, use of different materials with different properties, considerable motor skills and abstract reasoning to see how pieces of patterns are to be assembled on a three-dimensional object that changes shape."

## Knitting and crochet

There are multiple references to the similarity of knitting and crochet to computer programming; they involve detailed instructions for very specific steps, all of which must be present and in the correct order, and they involve repetition of sets of steps, much like logical structures such as "for" loops. In addition, similar to the syntax of computer programming, knitting and crochet patterns have very specific syntax to denote different types of stitches, such as "ch" to denote a chain stitch.

## Relationship between arts and crafts and technical education

There are currently a number of publications that have shifted from speaking of STEM to talking about STEAM, where the Science, Technology, Engineering, and Mathematics of STEM has Art added to it—i.e., Science, Technology, Engineering, Art and Mathematics. This is based in part on a recognition of the creativity that is inherent in practicing the traditional STEM professions, as well as an acknowledgement that the arts can enhance students' abilities in STEM subjects. In the article entitled "Using Creativity

TABLE 1 Characteristics of hobbies and related technical competencies.

| Hobby | Characteristic | Related technical competency |
|---|---|---|
| Sewing | Complex 3D shapes | Spatial Relations, Geometry |
| | Characteristics of different fabrics | Material Properties |
| Quilting | Drafting patterns | Geometry, Drafting |
| | Piecing | Precision, Measurement |
| Knitting/Crochet | Use of patterns | Algorithms |
| | Structured commands for stitches | Computer syntax |

from Art and Engineering", the ways in which arts-based activities could be used to enhance young students' understanding of the sciences and to express their understanding were described (Kuhn et al., 2016). These arts-based activities could include a variety of different things, including the traditionally feminine activities described here.

A study focused on gifted and talented students specifically looked at the role of arts and crafts to foster creativity in STEM education; the arts specified in that work included a variety of different pastimes including painting, music, woodworking, metalworking, mechanics, and electronics. This work cited a number of other studies that demonstrated in controlled studies that arts and crafts improve STEM learning, although it is notable that many of the specific crafts mentioned, such as woodworking and metalworking, are more often associated with men, while crafts generally associated with women were not specifically called out (Bottia et al., 2015). Furthermore, an earlier work by the same researcher that studied correlations between avocation and scientific qualities focused exclusively on data from interviewing 40 male scientists, and therefore it did not capture women's experiences (Root-Bernstein et al., 1995). Later work, again by the same researcher, did include women. This work looked at arts, crafts, and design avocations in STEMM professionals, where in this case the second "M" represents the addition of medical professionals to the typical STEM fields. While this work examined the influence of arts and crafts on thinking tools in STEMM fields and it did include both male and female participants, the differences and similarities of both typically masculine and typically feminine crafts were not considered (Root-Bernstein et al., 2019). As a result of these and other studies, it is generally accepted that the arts are associated with academic gain, as noted in Gullatt (2007), and this includes the STEM disciplines.

# Discussion/Conclusion

As these results have shown, there are distinct parallels between technical skills and many traditionally feminine hobbies. Table 1 lists some of the key characteristics and related technical aspects seen by the authors from the periodical and informal sources noted in this study.

These connections are sometimes explicitly stated, as in the study by Khalid and Ahmad (2021), which examines the relationship between employability skills and career adaptability among undergraduate students in the United Arab Emirates. However, in other cases, these connections are more implicit, indicating areas that are gaps in the existing literature.

The information presented in Berry (2006b) highlights the importance of recruiting a wider range of candidates for STEM careers, which is supported by the data about hobbies and careers. Almost 29 million Americans are involved in knitting and other yarn/thread arts (Morgan, 2024), while 9–11 million individuals are involved with quilting and other needle arts (Glassenberg, 2020). According to Career Theory, young people who learn and practice these skills early on are an untapped resource for future STEM professionals. Furthermore, significant anecdotal evidence supports STEAM, which integrates the arts into traditional science and technology-focused fields.

This aligns with the assertions found in the referenced periodic and informal articles cited earlier as well as early exposure to career awareness through strategies like career linkage models which support career learning in childhood, connecting different spheres like school, family, and the career community (Manowaluilou and Nilsook, 2023). The concept of career crafting, where individuals proactively shape their career paths, is integral to career theory. Studies indicate that career competencies, such as reflective, communicative, and behavioral competencies, are crucial for career success through job crafting behaviors (Akkermans and Tims, 2016). Additionally, self-goal setting, aligned with goal-setting theory, can promote career sustainability by propelling career crafting efforts (Ge et al., 2023). Incorporating childhood experiences, particularly engagement in craft and hobby activities, into career theory highlights the significance of early skill development and exploration.

Childhood vocational development models emphasize the foundational role of middle childhood in shaping later career decisions and outcomes (Porfeli et al., 2008). These models suggest that skills and mechanisms developed during childhood are essential for future vocational development. In conclusion, career theory, encompassing constructs like career construction, job crafting, and career competencies, offers a framework for understanding how individuals navigate their professional journeys. By integrating childhood experiences, such as participation in craft and hobby activities, into these theoretical perspectives, we can acknowledge the early development of skills and competencies influencing career trajectories in adulthood (Federici et al., 2019).

## Analysis of research sources found in this paper

The analysis of the preceding sources reveals a rich tapestry of interconnected themes that bridge the realms of arts and crafts with STEM disciplines, particularly focusing on knitting, quilting, and coding. The studies by LaMore et al. (2013) and collectively emphasize the significance of arts and crafts skills in fostering innovation, entrepreneurship, and overall well-being. These findings suggest that individuals with backgrounds in STEM fields often possess extensive arts and crafts skills, which can positively impact their ability to generate patentable inventions

and engage in entrepreneurial endeavors. Therefore, engaging in traditional arts and crafts activities is shown to contribute to cognitive capabilities, including mathematical comprehension, highlighting the cognitive benefits of such practices.

The integration of arts and crafts into STEM education is further supported by Lomov et al. (2001), who advocates for a pedagogical model that combines craft and art education to promote self-expression and creativity among students. Educators can nurture critical thinking skills essential for success in STEM fields by encouraging individuals to express themselves through craftwork. This approach aligns with the idea that hands-on experiences in the informal setting which can enhance interest and proficiency in STEM subjects, particularly among young learners, as highlighted by Todd and Zvoch (2019).

The study underscores the role of crafts in enabling individuals to utilize their full cognitive potential, aiding in comprehending complex mathematical concepts. This finding suggests that the hands-on nature of arts and crafts activities can enhance cognitive abilities, which are crucial for grasping intricate STEM principles. Moreover, the research by Gold (2011) on knitting, music, and programming reflects on the intersections between source code analysis and human-computer interaction, emphasizing the foundational role of source code analysis in operational software systems.

Furthermore, the study by Lomov et al. (2001) delves into the hierarchical structures of textile materials and the architecture of fabric geometric models, highlighting the mathematical and physical aspects inherent in textile design. This exploration of textile geometry underscores the intricate relationship between mathematics and artistry, showcasing how mathematical principles underpin the structural composition of fabrics. Additionally, the research by Cheng and Wu (2021) on intelligent wearable fabrics with sensory capabilities demonstrates the application of advanced materials science and chemistry in creating innovative textiles with remote diagnostic potential. In conclusion, the synthesis of these sources illuminates the profound connections between arts and crafts skills, such as knitting and quilting, and STEM aptitude, particularly in coding and computational domains. By recognizing the cognitive, creative, and innovative benefits of engaging in arts and crafts activities, educators can leverage these skills to enhance STEM learning experiences and cultivate a holistic skill set in individuals, preparing them for success in diverse and dynamic fields.

## Future work

Based on this survey, there are a number of avenues for research as well as implications for practice that should be pursued. To begin with, the connection between other forms of crafts and specific skills should be investigated, both by analyzing the content of those crafts and by studies of students' and practicing STEM professionals' skills and hobbies. Using existing, validated instruments for evaluating spatial relations and correlating that to various hobbies could reveal additional nuance on these connections, as well as revealing new ones. Other skills, known to be predictors of success in other STEM fields, could also be studied to confirm and extend existing correlations such as those in Table 1, as well as to reveal additional correlations.

In addition to adding to the knowledge base in this area, the connections to career theory, which was used as a lens to understand the existing material on this subject, should be further explored. For instance, current sources do not clearly articulate the link between skills learned from activities like sewing and spatial relations abilities. This highlights the need to explore further how childhood and other life experiences, such as engagement in craft and hobby activities, can shape skill development that influences career trajectories. By delving into research on career adaptability, career success evaluation indicators, and career education integrated into the study process (Chu et al., 2015; Manowaluilou and Nilsook, 2023), we can gain insights into how childhood and adult skill development can impact career outcomes. Additionally, considering theories like tolerance of uncertainty and planned happenstance skills (Kim et al., 2014, 2016), which influence career decision-making and self-efficacy, can provide a more comprehensive understanding of the role of early skill acquisition in shaping individuals' career paths.

Furthermore, implications for practice should be pursued more extensively and comprehensively than has been the case thus far. Clearly, many people have used the connection between traditionally feminine crafts and STEM skills to both seek out potential STEM students and to engage their interest; however, this knowledge should be spread more widely into the STEM community, particularly in light of some of the current efforts to push back against pre-college programs aimed at women and other under-represented groups (Knox, 2024). By showing a wider range of STEM professionals, educators, and the general public that traditionally feminine activities are not just compatible with but closely linked with STEM aptitudes, the attitude that women are not well suited to these careers may be changed over time.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

DP: Conceptualization, Formal analysis, Investigation, Methodology, Writing—original draft, Writing—review & editing. AL: Formal analysis, Investigation, Methodology, Writing—original draft, Writing—review and editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1377534/full#supplementary-material

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