<a>**Volunteer Participation, STEM Background, and Basic Skills among Adults in the US**

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Abstract

This chapter discusses three main topics: (1) volunteer as a form of civic engagement, (2) Science, Technology, Engineering and Mathematics (STEM), and (3) basic skills including literacy, numeracy and digital problem-solving skills. Volunteering, STEM background, and basic skills are important social and economic indicators of societies. Yet, little is known about volunteer participation by STEM background and basic skill proficiencies in the U.S. population. An analysis of the Program for International Assessment of Adult Competencies, U.S. restricted use file data showed that adults with a STEM background are more likely to volunteer than those without. Also, when adults with a STEM background have greater basic skill proficiencies, the likelihood of volunteering is even higher. That is, the positive associations between volunteering and a STEM background is likely be moderated by basic skill proficiencies. Based on the findings from this study, preliminary policy implications and important future research areas are evaluated.

KEYWORDS: Volunteering, STEM, skills, Literacy, Adult Education, United States

<b>**Introduction**

The goals of this chapter are (1) to provide concise background information on volunteering, Science, Technology, Engineering and Mathematics (STEM) skills, and basic skills, and (2) to present the descriptive summary of volunteer participation rates by STEM background and skill levels in the U.S. adult population. The outline of this chapter is summarized and visualized in Figure 1.

We first describe the basic definitions and importance of (1) volunteering as a form of civic engagement, (2) STEM background, and (3) basic skills. These three areas of interest are expressed as the rectangles in Figure 1 (also see the solid lines for what is known in the literature). Next, we briefly discuss the relationships among volunteering, STEM background, and skills (see the dotted lines in Figure 1). Then, the descriptive summary of the nationally-representative data of the U.S. adults from the Program for International Assessment of Adult Competencies (PIAAC) are presented (each specific relationship is numbered in Figure 1) (OECD, 2013). Finally, we evaluate preliminary implications for education and labor policy and highlight the important areas of future research. This chapter does not include a comprehensive review of the literature in all three areas of interest. However, we aim to provide a concise, descriptive summary and discussion across volunteering, STEM background, and skills at the national level to promote a novel area of research at the intersections of volunteering, STEM background, and skills.

<c>**What is volunteering?**

Volunteering is a form of civic engagement and is defined as an unpaid service provided to—and to benefit—an individual, organization, or charity (Wilson & Musick, 1997). Volunteering can be categorized into (1) formal and (2) informal volunteering (Wilson, 2000). Formal volunteering is referred to as services freely given to and occurring within an organization or charity. Examples include raising funds or preparing foods for a church, school, or political campaign. Informal volunteering is referred to as services freely given to a family, friend, or neighbor and occurring outside of an organization or charity. Examples include doing yard work for a neighbor or providing caregiving. Informal volunteering can also be characterized as episodic and spontaneous (Wang et al., 2017). In this chapter, we focus on formal volunteering.

Nearly one in three (30.3%) or 77.3 million Americans formally volunteered 6.9 billion hours a year through organizations in the U.S. (AmeriCorps, 2018). Common volunteer activities include raising funds (36.0%), donating foods, or preparing meals (34.2%), collecting and distributing clothing or other goods (26.5%), and mentoring youths (26.2%), among other activities. The top three volunteer categories in which volunteer activities occur include religious organizations (32.0%), sports and cultural organizations (25.7%), and education or youth services (19.2%).

<c>**Why is volunteering important?**

Volunteering is a beneficial form of civic engagement. At the individual level, those who volunteer are more likely to experience positive economic benefits like higher income and career advancements (Wilson et al., 2020), as well as greater physical and mental well-being (Jiang et al., 2021; McDougle et al., 2014; Tse, 2018) than non-volunteers. Further, both in and outside of formal volunteer activities, volunteers are more likely to engage in learning, which leads to new knowledge and skills (Rüber et al., 2018; Vera-Toscano et al., 2017). At the societal level, volunteering contributes to the economy. The estimated value of total volunteer hours is over $167 billion a year (AmeriCorps, 2018). Additionally, volunteering reinforces social well-being, such as collective social trust, social cohesion, and democracy (Atwell et al., 2017).

<b>**STEM Background**

<c>**Definition of STEM background**

In the last several decades, skills in Science, Technology, Engineering and Mathematics (STEM) subjects have been widely discussed in a variety of settings including education, labor, research, and public policy. Yet, the definitions of STEM skills have been somewhat flexible depending on the contexts, and as such, no universally agreed upon definition has been established to date. Generally, computer science, mathematics, architecture, engineering, life science, and physical science have been consistently classified as STEM fields (Vilorio, 2014). At times, STEM included other fields such as health care and social science. STEM definitions vary in general, and when discussing education and occupations, in particular (Xie et al., 2015). In the U.S., the Standard Occupational Classification (SOC) system, which is the national standard for classifying occupations into 23 major groups, is used to identify STEM occupations (Executive Office of the President Office of Management and Budget, 2018). The SOC system is comparable to the International Standard of Occupational Classification (ISOC) system (Shapiro et al., 2015). Lastly, the level and area of education data are primarily based on the International Standard Classification of Education (ISCED) in international reports (McFarland et al., 2018; UIS, 2012).

Enrollment in a sequence of STEM-related courses and/or completion of the relevant degree programs are considered STEM education, despite the diverse contents, curriculums, and outcomes (Xie & Killewald, 2012). By the same token, STEM occupations may or may not include some fields, such as health care and social sciences. Regardless of the industries, certain types of occupations, such as educators/trainers, managers, technicians, health care professionals, and social scientists, are only sometimes considered STEM occupations (Noonan, 2017).

<c>**Descriptive summary of STEM occupations and education in the U.S.**

In 2019, there were about 162 million employments in the U.S., and only about 6% or 10 million of them were considered STEM, although health care workers (except for scientists, engineers, and technicians in the health industry) and social scientists (except for technicians in the social science) were not included in the data (U.S. Bureau of Labor Statistics, 2021). When health care workers were included, the number of occupations considered STEM increased to 16% or 26 million (U.S. Bureau of Labor Statistics, 2020). STEM occupations have been growing more rapidly and the wages have been greater than non-STEM occupations (Noonan, 2017). Between 2019 and 2029, the projected growth rate of STEM occupations (not including health care occupations) is expected to be 8% compared to non-STEM occupations at 3.7%. When health care occupations are included as STEM occupations, the projected growth rate is expected to be

12.3% (U.S. Bureau of Labor Statistics, 2020). In 2020, the median annual wage for STEM occupations was $89,780, compared to $41,950 for non-STEM counterparts (U.S. Bureau of Labor Statistics, 2021). In part, due to the growth of STEM occupations and the recent national policy agenda (Johnson, 2012), STEM education has also been growing rapidly. In a 10-year period between 2009 and 2018, the number of STEM degrees and certificates increased from 486,855 to 756,825 (National Center for Education Statistics, 2020a).

<c>**Why are STEM occupations and education important to U.S. society?**

STEM skills have received growing attention for several reasons. STEM education and occupations are linked to technological and scientific innovation, which has made significant contributions to the U.S. economy in modern history (Xie & Killewald, 2012). Indeed, the strength of the U.S. economy comes from complex and non-labor intensive innovations, compared to that of, for example, China and India where relatively simple and labor-intensive innovations have stimulated the economy (Atkinson & Mayo, 2010). From a policy standpoint, the annual return of investment from publicly funded research and development are estimated between 20% and 67% (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007). Both STEM education and workforce are necessary to achieve the innovations and meet the demands of the current labor markets. In other words, without a STEM-educated workforce, technological and scientific innovations are unlikely to occur in the U.S. (Atkinson & Mayo, 2010). One concern is that innovations (e.g., job automation) could displace existing occupations and result in negative impacts on the economy. However, the Organization for Economic Cooperation and Development (OECD, 2019a) suggests that the economic benefits of innovations outweigh the risk of job displacement.

For individuals, STEM education and occupations are linked to higher socioeconomic status (SES) (e.g., income) in the U.S. (Rothwell, 2013). Also, STEM is related to upward social mobility (Xie et al., 2015). That is, the socioeconomic and social mobility benefits from STEM education and occupations seem to be greater among those in the lower positions of the social ladder than those already in the higher positions (Noonan, 2017). In this sense, increasing STEM education and occupations can contribute to addressing social inequality.

Finally, although often overlooked or understudied, education including both STEM and non-STEM subjects provides non-economic, non-monetary and/or non-market benefits—health, life satisfaction, civic engagement, and social well-being (e.g., social cohesion, social trust)—which are known as the wider benefits of education (Schuller & Desjardins, 2010). Notably, STEM education and occupations and resulting innovations have improved societal well-being and global prosperity through enhanced education, health care, transportation, and environmental sustainability (i.e., food and energy) (Atkinson & Mayo, 2010). However, compared to the economic benefits of STEM, non-economic benefits, such as civic engagement, are understudied in the U.S. (Rüber et al., 2018; Vera-Toscano et al., 2017).

<c>**Definition of STEM background**

In this chapter, both STEM education and occupations are considered STEM backgrounds. One of the broader definitions of STEM, which include “health,” “science and engineering,” and “information and communications technology” was employed and operationalized (Shapiro et al., 2015). Given the focus of this chapter—volunteering as a form of civic engagement among adult populations in the U.S.—a more inclusive STEM definition is appropriate (Koonce et al., 2011). The detailed classifications with specific codes are depicted in the methods section.

<b>**Basic Skills**

The concept of skills is fluid and often used interchangeably with other terms such as competency, knowledge, educational background, relevant experience, etc. Although skills and similar terms are explicitly distinguished in the literature, this chapter describes skills as part of a more inclusive concept of competency, "[…] *a combination of knowledge, skills, and attitude appropriate to the context*" (European Commission, 2007, p. 3). Additionally, here, skills refer to more basic, general, and interdisciplinary skills, rather than specific knowledge in one discipline (e.g., mathematics, biology). Basic skills are transferrable between work, social, and everyday contexts. In addition, basic skills, such as literacy and numeracy, are malleable at any life stage (OECD, 2013; Reder et al., 2020).

Measurement of skills is also diverse, both conceptually and methodologically. To focus on general and interdisciplinary skills, three sets of basic skills—including literacy, numeracy, and digital problem-solving skills—are considered. Each is defined as follows (see OECD, 2013, p. 20). Literacy is defined as "the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential." Numeracy is defined as "the ability to access, use interpret and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life." Digital problem-solving is defined as "the ability to use digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks." These sets of skills are used in national and international assessments of adult skills, such as PIAAC, and the usefulness of these skills as indicators of social and individual well-being are established in the global community (OECD, 2019b). Literacy, numeracy, and problem-solving skills are often considered basic skills, or information processing skills, and are the foundations for higher-order cognitive skills (e.g., creative thinking, analytical reasoning) as well as more context-specific skills such as financial, digital, civic and political, health, scientific, and STEM literacy (Atkinson & Mayo, 2010; Huguet et al., 2019; OECD, 2013).

<c>**Why are skills important?**

The importance of basic skills, such as literacy and numeracy, has been well-documented. Basic skills are known to be essential components of human capital, which is a collection of existing and acquired abilities and qualifications (e.g., educational attainment) that enhance one's economic advantage, occupational productivity, and career advancement (Becker, 2009). However, the benefits of basic skills are not limited to the economic realm (Reder, 2020). Indeed, basic skills are linked to, for example, advantages in employment and wages (Hanushek et al., 2013; Yamashita et al., 2018); civic engagement, such as volunteering (Grotlüschen et al. 2021; Rose et al., 2019); political efficacy and information seeking (Saal et al., 2020); and health (OECD, 2019b). Greater basic skills are associated with greater social cohesion, social trust, political participation, and lower crime rates, which collectively indicate social well-being (OECD, 2019b; Schuller, 2017). Importantly, basic skills are promoters of adult education and training participation (Desjardins, 2014; Yamashita et al., 2019). In a fast-changing, technology-rich society where new information frequently becomes available, it is also critical to be equipped with digital problem-solving skills. Finally, the benefits from basic skills enhance each other (e.g., civic engagement, literacy, and health; see Rikard et al., 2016).

<c>**STEM and Skills**

Adults with a STEM background tend to have higher literacy and numeracy skills than their non-STEM counterparts (Yao, 2019). Additionally, the STEM group is more likely to have greater information and communication technology skills than the non-STEM group (OECD, 2013). The relationships between STEM background and skills seem to be bi-directional. On the one hand, those with greater skills, numeracy, in particular, tend to choose STEM education and occupations (Wang, 2013). On the other hand, adults who are in STEM occupations tend to use and practice basic and applied skills at work and further enhance their skills. Indeed, STEM backgrounds are inherently linked to a range of science, computer, and technology literacies, which enable adults to practice critical and creative thinking (Atkinson & Mayo, 2010). In short, adults with a STEM background not only have higher baseline skills but can also improve their skills through more frequent practice than their non-STEM counterparts.

Adults with a STEM background may also have additional skill sets. For example, the concept of STEM, which is fundamentally interdisciplinary, may require adults to have complex cognitive and thinking skills across multiple disciplines (OECD, 2019b). STEM education and educational attainment overall are known to enhance a variety of capitals like human capital, which includes a set of knowledge and skills; social capital, which includes social support and resources from family, friends, and community; and identity capital, which includes personal aspirations and experiences gained within one’s lifetime. Taken together, these forms of capital, which can be developed through education over the life course, allow adults to participate effectively and efficiently in productive labor and public life, gain socioeconomic advantages, and cultivate a positive sense of self, motivation and determination (Rüber et al., 2018). Moreover, STEM-related knowledge and skills, such as management, technology application, critical thinking, and creative problem-solving, are often transferrable outside of STEM occupations (Noonan, 2017). As can be seen, adults with a STEM background are more likely to have both basic and other unique sets of skills, which are valuable to individual and societal well-being.

<c>**Objectives**

Volunteering as a form of civic engagement plays a critical role for the economy and social well-being of the U.S. STEM education and occupations are indispensable driving forces of the innovation-based economy in the U.S., and are contributing factors for global economic competitiveness, as well as beneficial to individual and social well-being (e.g., human and social capitals). Adults with STEM education and occupations are more likely to possess greater basic skills, such as literacy and numeracy, as well as unique sets of skills (e.g., technology-based creative problem-solving) than those without (Yao, 2019). A better understanding of volunteer participation and basic skills by STEM background is beneficial to promote and maximize the value of civic engagement.

However, relatively little is known about the relationships between volunteering, STEM background, and basic skills in the U.S. adult population. Therefore, based on the nationally representative data, the objectives of this chapter are to explore the distributions of volunteering, STEM background, and basic skills, and then to examine baseline relationships among them in hopes to provide the essential information for policy discussions, and more rigorous empirical research in the future.

<b>**Methods**

Data on U.S. adults were obtained from survey data collected in 2012/2014/2017 in the Program for the International Assessment of Adult Competencies (PIAAC) restricted-use file (RUF), which requires a data security plan and compliance with the data use guidelines of the National Center for Education Statistics (see Appendix E in Krenzke et al., 2019). PIAAC is an ongoing large-scale assessment of adult skills in selected OECD member countries. The PIAAC assessments include computer-adapted assessments of literacy, numeracy, and digital problem-solving skill proficiencies and provides them as a form of plausible values, which are in a set of ten statistically estimated skill proficiency scores ranging from 0 to 500 (the highest). To focus on the adult population after initial formal schooling, we selected adults aged 25 years and older. Although the respondents were from three different time points in the PIAAC RUF data, adjusted sampling weights were used to estimate the nationally-representative skill proficiencies and other information reflecting the period 2012–2017. After selecting eligible participants, the final sample size was 9,460.

<c>**Measures**

Volunteer participation was assessed based on the PIAAC survey item, "*In the last 12 months, how often, if at all, did you do voluntary work, including unpaid work for a charity, political party, trade union or other non-profit organization?*" The response was recorded in two ways: (1) a dichotomous measure of at least one participation in the last twelve months. vs. never; and

(2) a one to five Likert-type response scale with the response alternatives: *never*; *less than once a month*; *less than once a week but at least once a month*; *at least once a week but not every day*; and *every day*.

STEM background was assessed based on whether the respondent currently worked in a STEM occupation or had a college-level STEM degree or education. Specifically, we classified ISOC codes 21 (science and engineering professionals), 22 (health professionals), 25 (information and communications technology professionals), 31 (science and engineering associate professionals), 32 (health associate professionals), and 35 (information and communications technicians) as STEM occupations (Shapiro et al., 2015). In terms of ISCED levels, we classified respondents with college-level degrees in science, mathematics, computing, engineering, manufacturing, and construction as STEM educated. Given that health-related college-level degrees were combined with other non-STEM programs (e.g., social welfare), we did not include them in STEM education.

<d>*Low-level skills, mid-level skills and high-level skills*

PIAAC skill proficiency scores were converted to *skill levels* for more meaningful and accessible comparisons for the purpose of data explorations. Per the PIAAC proficiency level classifications, previous national reports and data distributions, literacy and numeracy were converted to low-level skills (level 1 and below, or lower than 226); mid-level skills (level 2 or 226 or higher, and lower than 276); and high-level skills (level 3, level 4 and level 5 or 276 and higher), and digital problem-solving skills were converted to low-level skills (below level 1 or lower than 241); mid-level skills (level 1 or 241 or higher, and less than 291); and high-level skills (level 2 and level 3, or 291 or higher) (National Center for Education Statistics, 2019; OECD, 2019b).

<c>**Analytic approach**

Following the general exploratory data analysis guidelines by John Tukey (Brillinger, 2011), we computed a weighted descriptive summary of volunteer participation, STEM background, and basic skills; visualized the data; conducted the bivariate significance tests by the STEM backgrounds; and kept the analysis parsimonious (bivariate analysis with the Chi-square test). The analysis was conducted using SAS version 9.4 (Copyright © 2013, SAS Institute, Inc.) and the IDB analyzer (IEA, 2016). The IDB analyzer generates the SAS macro programs that take all plausible values (PVLIT1-PVLIT10; PVNUM1-PVNUM10; PVPSL1-PVPSL10), sampling weights (SPFWT0) and replicate weights (SPFTW1-SPFWT80) into account to estimate the nationally-representative figures. The statistical significance was evaluated with the p-value of less than 0.05.

<b>**Results**

The weighted descriptive summary is presented in Table 1, and selected key findings are visualized in Figures 2–6. Approximately 19% of adults surveyed in PIAAC 2012/2014/2017 had a STEM background. The STEM group (60%) was more likely to have volunteered than the non-STEM group (52%) in the past twelve months. Yet, given the difference in the baseline number of populations, only about one in five volunteers (22 out of 98 million) had a STEM background. In addition, the STEM group tended to volunteer more frequently than the non-STEM group (Data source: National Center for Education Statistics, *PIAAC*, Restricted Use File, U.S. Department of Education, 2012/2014/2017; see Krenzke et al., 2019). Interestingly, those with a STEM background and those who volunteered were more likely to have greater skill proficiencies in all three domains (for example, see Figures 2 and 3 for the digital problem-sovling skills).

However, among volunteers, the non-STEM group had slightly higher percentages of at least once a week and every day. Also, the STEM group had greater skill proficiencies than their counterparts. Indeed, about 66%, 59% and 49% of the STEM group had high literacy, numeracy, and digital problem-solving proficiencies, compared to 42%, 33% and 30% among the non-STEM group (see Table 1). Moreover, volunteers were more likely to have high skill proficiencies than non-volunteers in all three areas of skills, regardless of STEM background (see Figures 4-6). Finally, when comparing skill proficiency levels, STEM, and volunteerism, the STEM group the STEM group was more likely to volunteer than the non-STEM group (e.g., for literacy, 42% vs. 33%, respectively). On the other hand, among adults with high skill proficiencies, the STEM group was slightly less likely to volunteer than the non-STEM group (e.g., for literacy, 64% vs. 66%; see Figures 4-6).

<b>**Discussion**

The exploratory analysis of the nationally-representative data from PIAAC 2012 –2017 (National Center for Education Statistics, 2012/2014/2017) showed the baseline associations among volunteering as a form of civic engagement, STEM background, and basic skill proficiency. Along with the estimated percentages in the adult population in the U.S., the findings are useful for informing policy discussions as well as for identifying important areas in future research. Here, we provide a brief discussion on the preliminary policy suggestions and important areas for future research.

<c>**Preliminary policy suggestions**

Given the higher basic and unique sets of skills among adults with a STEM background, actively recruiting volunteers from the STEM group may lead to the additional value of volunteering. It is possible that volunteering and socially interacting with those with a STEM background may inspire those without a STEM background to engage in STEM education and occupations. Notably, STEM outreach volunteer programs have been getting more attention in recent years (see Corporation for National & Community Service, 2015 for examples of the federal programs.). This chapter showed that adults with a STEM background are more likely to volunteer than those without. At the same time, the number of people in the STEM group is considerably smaller than the non-STEM group. Promoting STEM education at postsecondary education institutions, such as community colleges and universities, is critical to supply a STEM-educated workforce and boost the scientific and technological innovations in the U.S. Moreover, growing STEM education may translate into more volunteer participation. Also, it is a wise investment to incorporate basic and other (e.g., digital problem-solving) education and training into formal volunteer programs, which may incentivize volunteer participation and perhaps enrich volunteer experiences, especially among younger adults (Flanagan & Levine, 2010).

<c>**Suggested future research areas**

We suggest two important areas for future research. First, building on the baseline findings from this chapter, future research should expand the scope of analysis by incorporating different types of civic engagement (e.g., voting) and the relevant factors or covariates, and disentangle complex pathways between civic engagement, STEM background, and basic skills. Specifically, identification of main reasons why adults with a STEM background are more likely to volunteer, specific types of basic skills that promote volunteer participation, and more detailed inquiries of STEM and its sub-fields would inform interventions and policies that promote civic engagement, STEM education and occupations, and basic skills development in the U.S.

Second, future research needs to document the differences across demographic and socioeconomic characteristics, and to identify potential causal mechanisms. In all three areas, including volunteering, STEM, and basic skills, systematic social inequality is evident. For example, White adults (26%) participate more in formal volunteering than Black (19%) or Hispanic (16%) adults (U.S. Bureau of Labor Statistics, 2016). Additional research is needed to examine volunteer participation by race and ethnicity for both formal and informal volunteer activities. In 2018, 33% of postsecondary STEM degrees and certificates were awarded to women, and 26% of postsecondary degrees were awarded to Black and Hispanic populations, which account for about 32% of the total population (National Center for Education Statistics, 2020a). According to the most recent PIAAC data, White adults (average literacy score = 283) tend to have greater basic skills than Black (242), Hispanic (251) and other racial and ethnic minority (266) adults (National Center for Education Statistics, 2020b). Generally, socioeconomic status (e.g., income and employment), human capital (e.g., education and skills), and sociodemographic groups (e.g., gender, race and ethnicity, age) jointly determine participation in volunteering (Wilson & Musick, 1997). While biased sociocultural norms (e.g., math is for men), disproportionate opportunity structures, and socioeconomic inequality seem to contribute to the STEM education and occupation gaps by gender, race and ethnicity, more specific reasons for the gaps are yet to be identified in future research (Xie et al., 2015). Finally, it is critical to examine the intersections of race, class, and gender to better understand the unique experiences by, for example, Black women and men (Crenshaw, 1989) as related to different forms of volunteer participation, STEM backgrounds, and basic skills.

<b>**Acknowledgment**

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<b>**References**

AmeriCorps. (2018). *Volunteering in U.S. Hits record high; worth $167 billion.* Retrieved May 25, 2021 from https://www.nationalservice.gov/newsroom/press-releases/2018/volunteering-us-hits-record-high-worth-167-billion

Atkinson, R. D., & Mayo, M. J. (2010). *Refueling the US innovation economy: Fresh approaches to science, technology, engineering and mathematics (STEM) education*. The Information Technology & Innovation Foundation. https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID1722822_code666235.pdf?abstractid=1722822&mirid=1

Atwell, M. N., Bridgeland, J., & Levine, P. (2017). *Civic Deserts: America's Civic Health Challenge.* National Conference on Citizenship. https://www.ncoc.org/wp-content/uploads/2017/10/2017CHIUpdate-FINAL-small.pdf

Becker, G. S. (2009). *Human capital: A theoretical and empirical analysis, with special reference to education* (3rd ed., pp. 29-58). University of Chicago Press.

Brillinger, D. R. (2011). Data Analysis, Exploratory. In B. Badie, D. Berg-Schlosser, & L. Morlino (Eds.), *International Encyclopedia of Political Science* (pp. 531-537). SAGE Publications, Inc. https://doi.org/10.4135/9781412994163

Corporation for National & Community Service. (2015). *Engaging the federal workforce in stem volunteer service.* Retrieved May 25, 2021 from https://www.nationalservice.gov/sites/default/files/documents/Consolidated%20Brightspots%20and%20Synthesis_Withtemplate%20(2)_2.pdf

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, 1989(1), 139-168.

Desjardins, R. (2014). *Participation in adult education opportunities: Evidence from PIAAC and policy trends in selected countries*. Background paper for the Education for All Global Monitoring Report 2015, UNESCO.

European Commission. (2007). Key competencies for lifelong learning: European reference framework. European Commission. http://hdl.voced.edu.au/10707/285153

Executive Office of the President Office of Management and Budget. (2018). *Standard occupational classificaiton manual*. https://www.bls.gov/soc/2018/soc_2018_manual.pdf

Flanagan, C., & Levine, P. (2010). Civic Engagement and the Transition to Adulthood. *The Future of Children*, *20*(1), 159-179. http://www.jstor.org/stable/27795064

Grotlüschen, A., Chachashvili-Bolotin, S., Heilmann, L., & Dutz, G. (2021) Beyond literacy and language provision: Socio-political participation of migrants and large language minorities in five countries from PIAAC R1/R2. Journal of Adult and Continuing Education, 27(1), 42-62. https://doi.org/10.1177/1477971419898491

Hanushek, E. A., Schwerdt, G., Wiederhold, S., & Woessmann, L. (2013). *Returns to Skills around the World: Evidence from PIAAC*. NBER Working Paper Series, *73*(2015), 103-130. https://www.nber.org/system/files/working_papers/w19762/w19762.pdf

Huguet, A., Kavanagh, J., Baker, G., & Blumenthal, M. S. (2019). Exploring Media Literacy Education as a Tool for Mitigating Truth Decay. RAND Corporation. https://doi.org/10.7249/RR3050

IEA. (2016). *Help manual for the IDB analyzer (SAS macros).* Retrieved October 1, 2021 from http://www.iea.nl/data

Jiang, D., Warner, L. M., Chong, A. M.-L., Li, T., Wolff, J. K., & Chou, K.-L. (2021). Benefits of volunteering on psychological well-being in older adulthood: evidence from a randomized controlled trial. *Aging & Mental Health*, *25*(4), 641-649. https://doi.org/10.1080/13607863.2020.1711862

Johnson, C. C. (2012). Implementation of STEM Education Policy: Challenges, Progress, and Lessons Learned. *School Science and Mathematics*, *112*(1), 45-55. https://doi.org/https://doi.org/10.1111/j.1949-8594.2011.00110.x

Koonce, D. A., Zhou, J., Anderson, C. D., Hening, D. A., & Conley, V. M. (2011). *What is STEM?* ASEE Annual Conference & Exposition, Vancouver, BC. https://peer.asee.org/what-is-stem.pdf

Krenzke, T., VanDeKerckhove, W., Thornton, N., Diaz-Hoffmann, L., Hogan, J., Mohadjer, L., Li, L., Li, J., Yamamoto, K., Khorramdel, L., & Ali, U. (2019). U.S. Program for the International Assessment of Adult Competencies (PIAAC) 2012/2014/2017: Main Study, National Supplement, and PIAAC 2017 Technical Report. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2020224

McDougle, L., Handy, F., Konrath, S., & Walk, M. (2014). Health outcomes and volunteering: The moderating role of religiosity. *Social Indicators Research, 117*(2), 337-351. https://doi.org/10.1007/s11205-013-0336-5

McFarland, J., Hussar, B., Wang, X., Zhang, J., Wang, K., Rathbun, A., Barmer, A., Forrest Cataldi, E., & Bullock, M., F. (2018). *Education Indicators: An International Perspective.* NCES. https://nces.ed.gov/pubs/eiip/

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* The National Academies Press. https://doi.org/doi:10.17226/11463

National Center for Education Statistics. (2019). *Adult literacy in the United States.* U.S. Department of Education, Institute of Education Sciences. https://nces.ed.gov/pubs2019/2019179.pdf

National Center for Education Statistics. (2020a). *Digest of Education Statistics.* U.S. Department of Education, Institute of Education Sciences. Retrieved May 18, 2021 from https://nces.ed.gov/programs/digest/index.asp

National Center for Education Statistics. (2020b). *Highlights of the 2017 U.S. PIAAC Results Web Report.* U.S. Department of Education, Institute of Education Sciences. Retrieved May 18, 2021 https://nces.ed.gov/surveys/piaac/current_results.asp

Noonan, R. (2017). *STEM Jobs: 2017 Update*. Economics and Statistics Administration Issue Brief. U.S. Department of Commerce Economics and Statistics Administration Office of the Chief Economist. http://files.eric.ed.gov/fulltext/ED594354.pdf

OECD. (2013). What the survey of adult skills (PIAAC) measures. In *The survey of adult skills: Reader's Companion*. OECD Publishing. https://doi.org/10.1787/9789264204027-4-en

OECD. (2019a). *OECD Employment Outlook 2019*. OECD Publishing. https://doi.org/10.1787/9ee00155-en

OECD. (2019b). *Skills matter: Additional results from the Survey of Adult Skills*. OECD Skills Studies. OECD Publishing. https://doi.org/10.1787/9789264258051-en

Reder, S. (2020). A lifelong and life-wide framework for adult literacy education. *Adult Literacy Education, 2*(2), 48-53. https://doi.org/10.35847/SReder.2.1.48

Reder, S., Gauly, B., & Lechner, C. (2020). Practice makes perfect: Practice engagement theory and the development of adult literacy and numeracy proficiency. *International Review of Education, 66*(2), 267-288. https://doi.org/10.1007/s11159-020-09830-5

Rikard, R. V., Thompson, M. S., McKinney, J., & Beauchamp, A. (2016). Examining health literacy disparities in the United States: a third look at the National Assessment of Adult Literacy (NAAL). *BMC Public Health*, *16*(975). https://doi.org/10.1186/s12889-016-3621-9

Rose, A. D., Smith, T. J., Ross-Gordon, J. M., Zarestky, J., Lopes, T., Cecil, S. M., Grotlüschen, A., & Fleige, M. (2019). *Adults' Civic Engagement in the U.S. and Germany: Evidence from the PIAAC Survey*. PIAAC Gateway. OECD Publishing. http://piaacgateway.com/s/2019_Rose_Adults_Civic_Engagement_US_Germany.pdf

Rothwell, J. (2013). *The hidden STEM economy.* The Brookings Institute. https://www.brookings.edu/research/the-hidden-stem-economy/

Rüber, I. E., Rees, S.-L., & Schmidt-Hertha, B. (2018). Lifelong learning – lifelong returns? A new theoretical framework for the analysis of civic returns on adult learning. *International Review of Education*, *64*(5), 543-562. https://doi.org/10.1007/s11159-018-9738-6

Saal, L. K., Yamashita, T., Shaw, D. M., & Perry, K. H. (2020). An exploration of U.S. adults' information processing skills and political efficacy. *Journal of Adult and Continuing Education*, *26*(2), 178-202. https://doi.org/10.1177/1477971419852750

Schuller, T. (2017). *What are the wider benefits of learning across the life course?* Government Office for Science. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/635837/Skills_and_lifelong_learning_-_the_benefits_of_adult_learning_-_schuller_-_final.pdf

Schuller, T., & Desjardins, R. (2010). Wider Benefits of Adult Education. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International Encyclopedia of Education* (3rd ed., pp. 229-233). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-08-044894-7.00045-2

Shapiro, H., Østergård, S., & Hougard, K. (2015). *Does the EU need more STEM graduates?* Publications Office of the European Union. https://op.europa.eu/s/pbOC

Tse, D. C. K. (2018). Volunteers' Felt Respect and Its Associations With Volunteering Retention, Daily Affect, Well-being, and Mortality. *The Journals of Gerontology: Series B*, *75*(8), 1625-1636. https://doi.org/10.1093/geronb/gby117

U.S. Bureau of Labor Statistics. (2016). *Volunteering in the United States - 2015* (News Release, Issue. https://www.bls.gov/news.release/pdf/volun.pdf

U.S. Bureau of Labor Statistics. (2020). *Employment projections: Employment by major industry sector.* U.S. Bureau of Labor Statistics. Retrieved June 2 from https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm

U.S. Bureau of Labor Statistics. (2021). *Employment in STEM occupations.* Retrieved May 18 from https://www.bls.gov/emp/tables/stem-employment.htm

UIS (2012). International Standard Classification of education, ISCED 2011. Montreal: UNESCO Institute for Statistics. http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf

Vera-Toscano, E., Rodrigues, M., & Costa, P. (2017). Beyond educational attainment: The importance of skills and lifelong learning for social outcomes. Evidence for Europe from PIAAC. *European Journal of Education*, *52*(2), 217-231. https://doi.org/https://doi.org/10.1111/ejed.12211

Vilorio, D. (2014). STEM 101: Intro to tomorrow's jobs. *Occupational Outlook Quarterly, 58*(1), 2-12. https://www.bls.gov/careeroutlook/2014/spring/art01.pdf

Wang, L., Mook, L., & Handy, F. (2017). An empirical examination of formal and informal volunteering in Canada. *VOLUNTAS: International Journal of Voluntary and Non-profit Organizations*, *28*(1), 139-161.

Wang, X. (2013). Why Students Choose STEM Majors: Motivation, High School Learning, and Postsecondary Context of Support. *American Educational Research Journal*, *50*(5), 1081-1121. https://doi.org/10.3102/0002831213488622

Wilson, J. (2000). Volunteering. *Annual Review of Sociology*, *26(*1), 215-240. https://doi.org/10.1146/annurev.soc.26.1.215

Wilson, J., Mantovan, N., & Sauer, R. M. (2020). The economic benefits of volunteering and social class. *Social Science Research, 85*(1). 102368. https://doi.org/https://doi.org/10.1016/j.ssresearch.2019.102368

Wilson, J., & Musick, M. (1997). Who Cares? Toward an Integrated Theory of Volunteer Work. *American Sociological Review*, *62*(5), 694-713. https://doi.org/10.2307/2657355

Xie, Y., Fang, M., & Shauman, K. (2015). STEM Education. *Annual Review of Sociology, 41*(1), 331-357. https://doi.org/10.1146/annurev-soc-071312-145659

Xie, Y., & Killewald, A. A. (2012). *Is American Science in decline?* Harvard University Press.

Yamashita, T., Cummins, P. A., Arbogast, A., & Millar, R. J. (2018). Adult Competencies and Employment Outcomes Among Older Workers in the United States: An Analysis of the Program for the International Assessment of Adult Competencies. *Adult Education Quarterly*, *68*(3), 235-250. https://doi.org/10.1177/0741713618773496

Yamashita, T., Cummins, P. A., Millar, R. J., Sahoo, S., & Smith, T. J. (2019). Associations between motivation to learn, basic skills, and adult education and training participation among older adults in the USA. *International Journal of Lifelong Education, 38*(5), 538-552. https://doi.org/10.1080/02601370.2019.1666927.2019.1665310

Table 1: Weighted Descriptive Summary

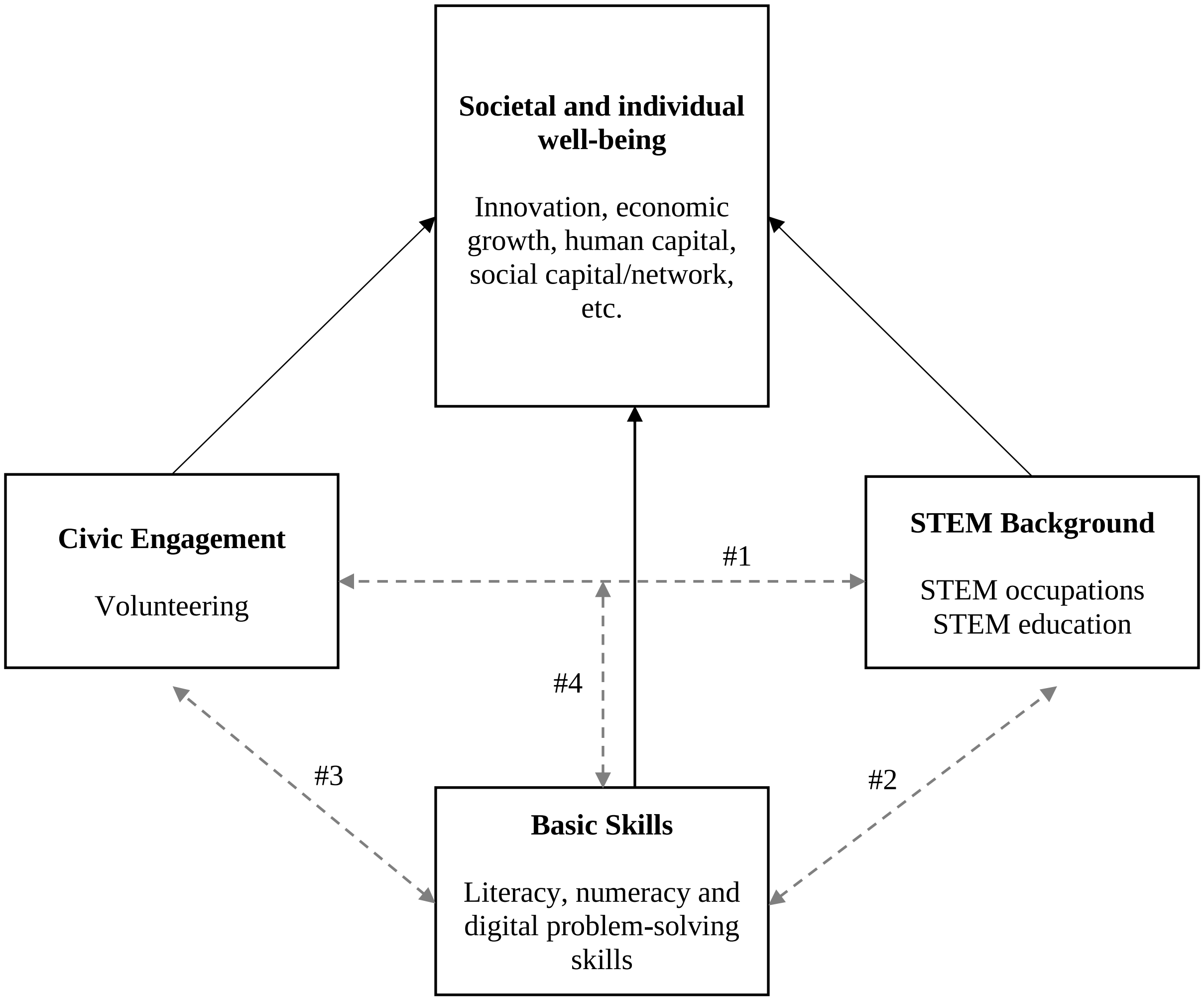
Measures	All Samples (n = 9,460) Weighted mean (standard deviation) or percentage	STEM Background (n = 1,830) Weighted mean (standard deviation) or percentage	Non-STEM Background (n = 7,630) Weighted mean (standard deviation) or percentage
Volunteer participation in the last 12 months (Yes)	53.90%	59.75%*	52.42%
Frequency of volunteer participation in the last 12 months		*	
Never	46.06%	40.25%	47.59%
Less than once a month	24.13%	29.54%	22.74%
Less than once a week but at least once a month	14.56%	16.81%	13.95%
At least once a week but not every day	12.78%	11.46%	13.09%
Everyday	2.48%	1.93%	2.63%
Literacy skill levels		*	
Low	19.78%	9.14%	22.27%
Medium	33.05%	24.95%	35.14%
High	41.17%	65.91%	42.40%
Numeracy skill levels		*	
Low	29.02%	14.02%	32.83%
Medium	32.87%	27.21%	34.34%
High	38.11%	58.77%	32.83%
Digital problem-solving skill levels		*	
Low	26.10%	15.98%	29.17%
Medium	39.54%	35.00%	40.89%
High	34.37%	49.02%	29.94%
Age	47.60 (13.66)	45.67 (12.94)*	48.12 (13.83)
Gender (Female)	51.71%	40.78%*	54.72%
Race & Ethnicity			
White	67.55%	71.53%*	66.54%
Black	12.03%	8.11%*	12.99%
Hispanic	12.85%	8.61%*	13.98%
Others	7.57%	11.76%	5.49%
Educational attainment (college or higher)	42.36%	75.50%*	52.27%
Total years of education	13.81 (2.99)	15.34 (2.42)*	13.38 (3.00)
Parents' or guardians' educational attainment (college of higher)	37.40%	50.03%*	34.02%
U.S. born	84.86%	81.67%*	85.66%
Employment status			
Employed	72.12%	84.17%*	68.94%
Unemployed	4.16%	2.93%*	4.48%
Out of labor force	23.73%	12.89%*	26.58%
Self-rated health (1-5 = Poor - Excellent)	3.49 (1.08)	3.77 (0.97)*	3.42 (1.10)

Note: see #1 and #2 in Figure 1. The figures should be considered the mean basic skill proficiency scores between 2012 and 2017. The sampling weight (SPFWT0) and 80 replicate weights (SPFWT1-SPFWT80) were applied, as appropriate. Per the U.S. Department of Education Restricted File Use Guidelines, the figures were rounded to the nearest 10

Source: Table constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.

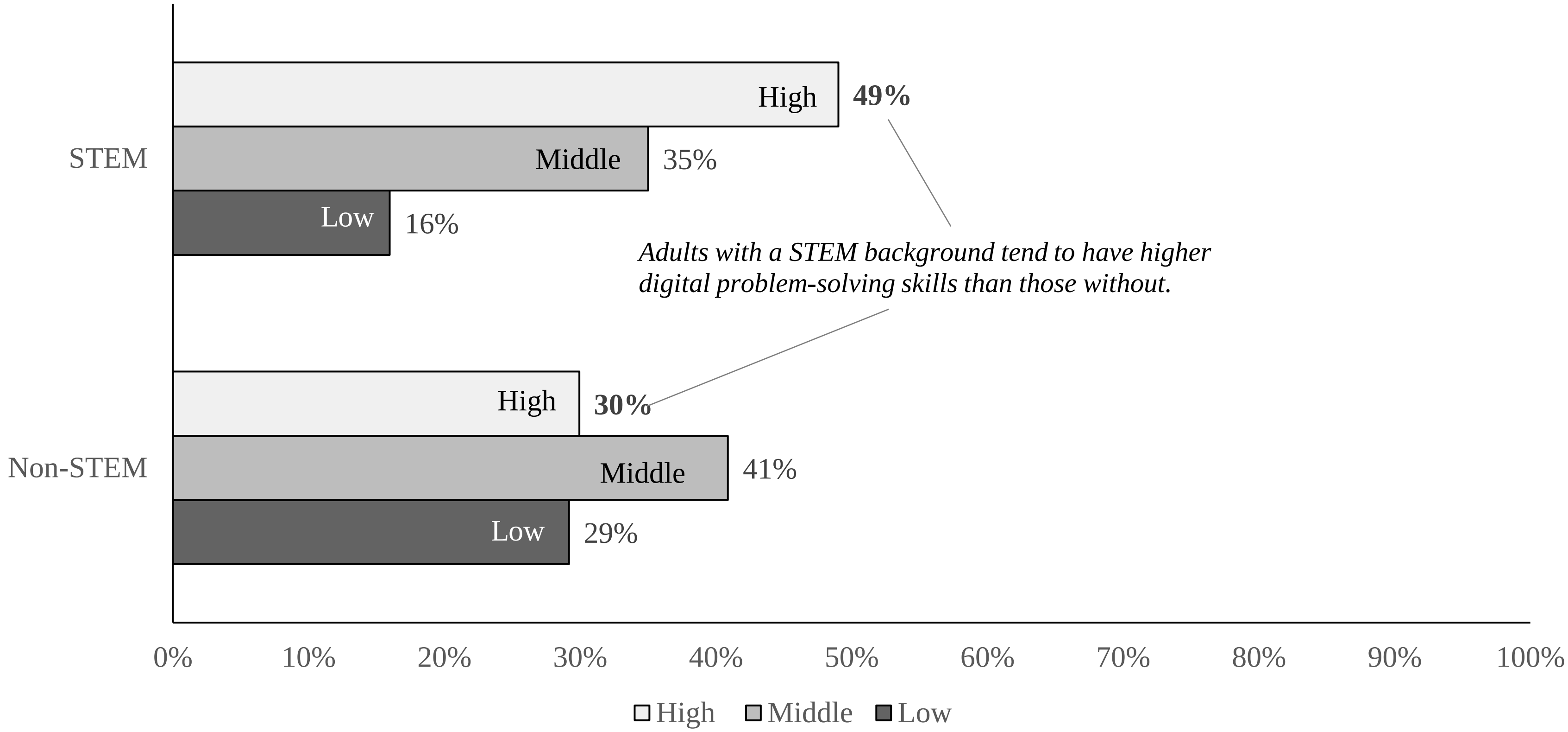
*$p < 0.05$, based on the chi-square test from the weighted simple binary logistic regression, either across the categories or by category between the STEM background, according to the levels (categorial, ordinal/continuous) of measure.

Figure 1. Visualized Chapter Outline



Note: This chapter addresses the dashed lines. The solid lines represent what is known from the literature.
Source: Authors

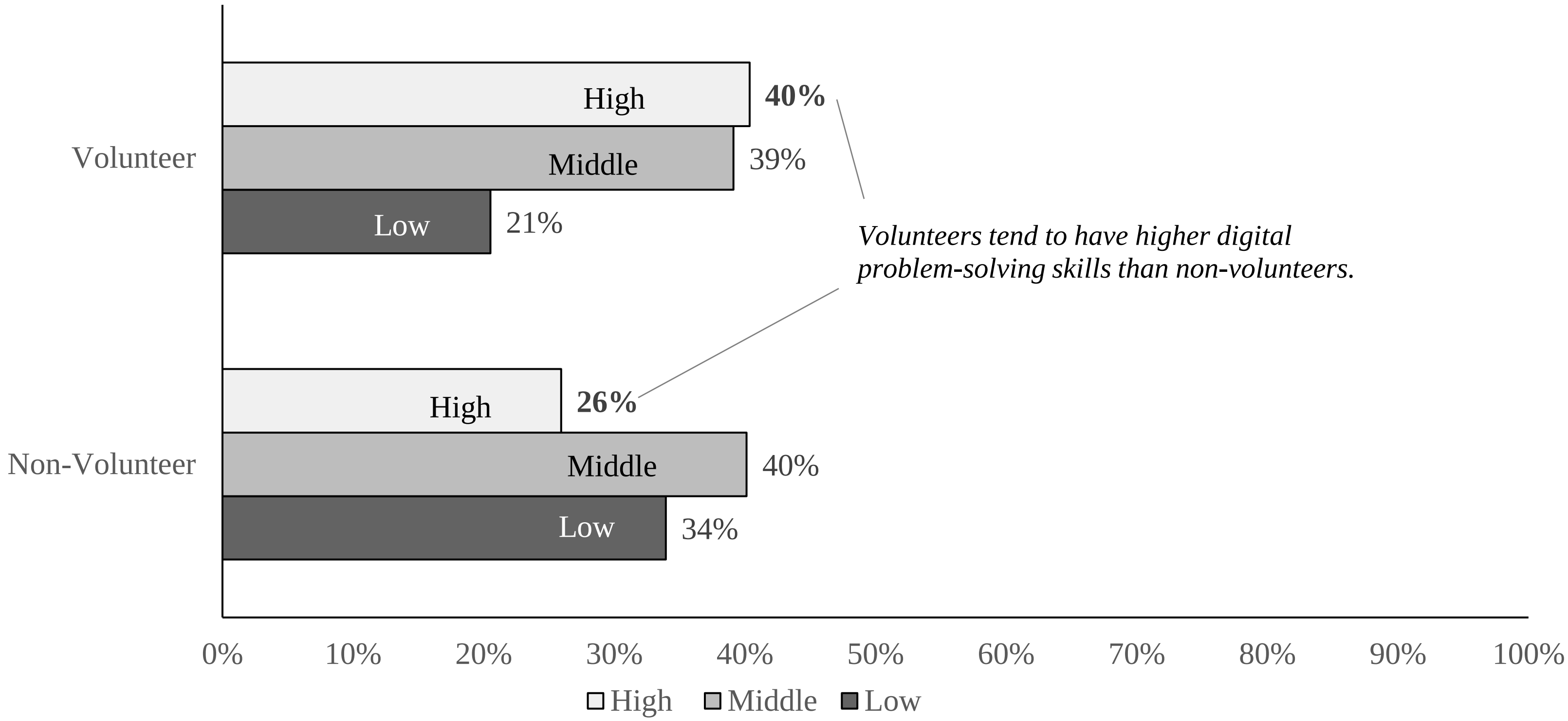
Figure 2. Digital Problem-Solving Skill Levels by STEM Background



see #2 in Figure 1

Source: Authors; Figure constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.

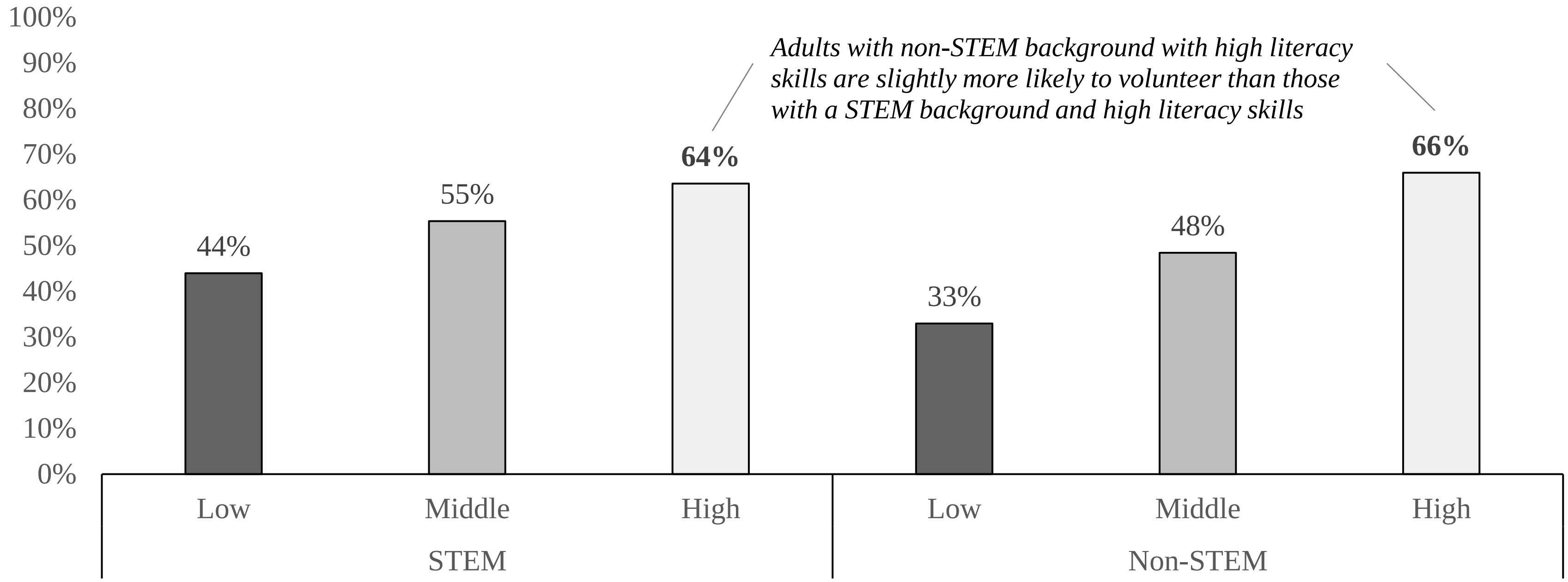
Figure 3: Digital Problem-Solving Skill Levels by Volunteer Participation



see #3 in Figure 1

Source: Authors; Figure constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.

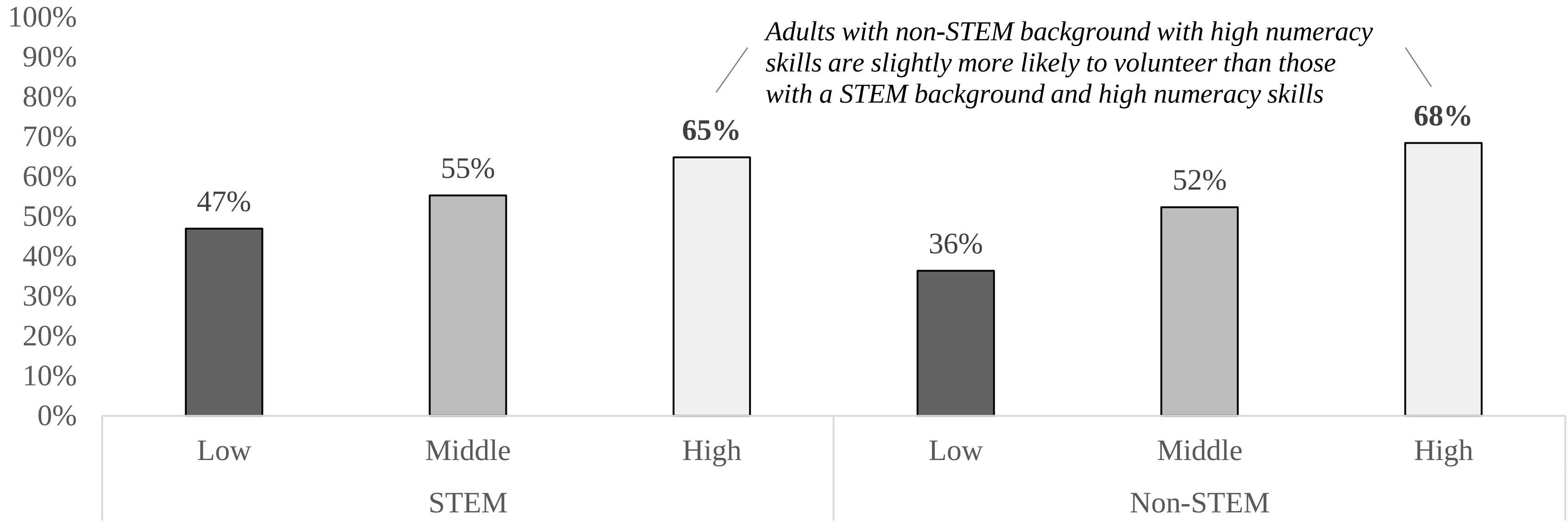
Figure 4. Volunteer Participation by Literacy Skill Levels and STEM Background



see #4 in Figure 1

Source: Authors; Figure constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.

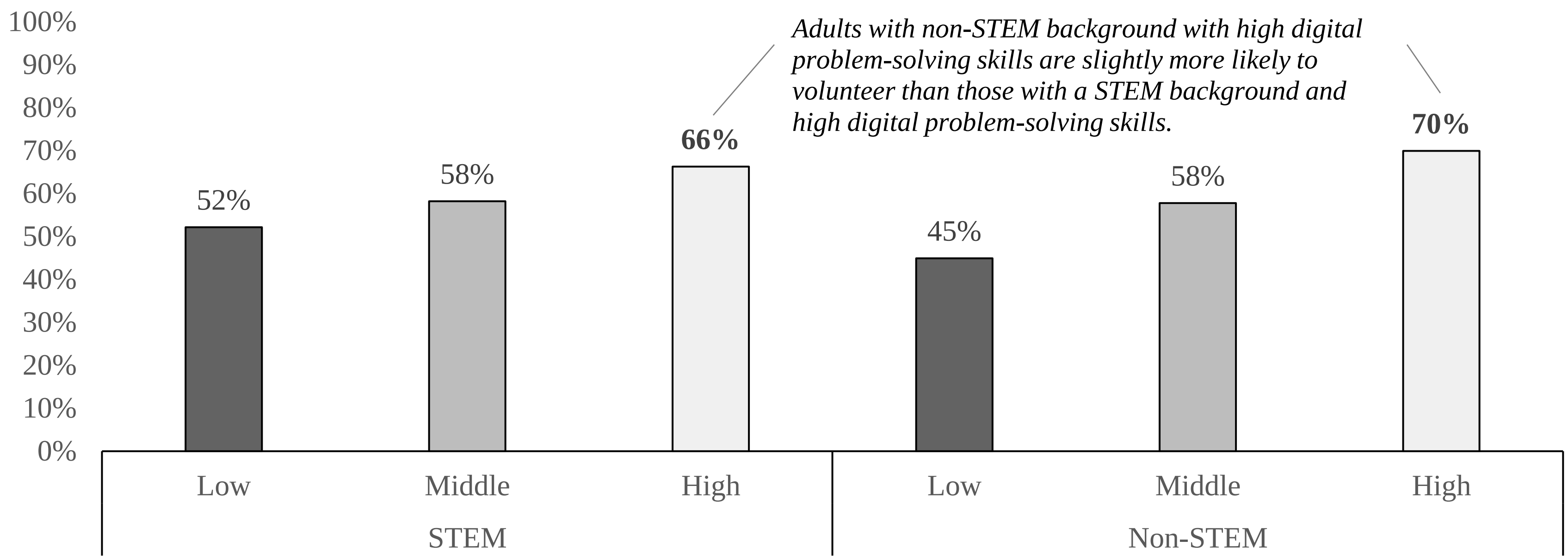
Figure 5. Volunteer Participation by Numeracy Skill Levels and STEM Background



see #4 in Figure 1

Source: Authors; Figure constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.

Figure 6. Volunteer Participation by Digital Problem-Solving Skill Levels and STEM Background



see #4 in Figure 1

Source: Authors; Figure constructed by the authors using data from the U.S. Department of Education, National Center for Education Statistics, 2012/2014/2017, Program for International Assessment of Adult Competencies Restricted Use File.