Technical Socialization and Personality Traits as Predictors of the Need for Cognition in Technology Education?

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Abstract

In a technology-driven society, the development of problem-solving skills among young students is becoming an increasingly important outcome in school education. At the same time, there is a well-documented decline in interest in technology among young people and persistent gender differences in science, technology, engineering, and mathematics (STEM) subjects. The present study examines the extent to which technical socialization and personality traits influence the Need for Cognition (NfC) among students by addressing the question: What correlations can be revealed between gender, personality traits, technical socialization and NfC? In answering that question, the research aim is to use the insights gained from these correlations to best support the development of problem-solving abilities among students of both genders in all technology subjects, but specifically that of Technology Education and/or Design and Technology Education.

NfC describes the stable tendency to engage in cognitively demanding tasks and to experience thinking processes as intrinsically satisfying. In a quantitative online questionnaire secondary school students (N = 614) were asked about their technical socialization, personality traits (Big Five), and the extent of their NfC. The data were evaluated using t-tests and variance analyses.

The results show gender-specific differences in technical socialization, but no differences in NfC levels. Openness to experience is the only significant predictor of NfC. The findings provide starting points for teachers of Technology Education and/or Design and Technology Education with regard to helping ensure gender-sensitive implementation of school programs.

Keywords: Gender and Technology, Need for Cognition, Technical Socialization, Technology Education, Design and Technology Education

Goreth, S., (2026). Technical Socialization and Personality Traits as Predictors of the Need for Cognition in Technology Education? *38*(1), 75-97. https://doi.org/10.21061/jte.v38i1.a.4

Introduction

The use of technical artifacts, which is often reduced to mere operation, is omnipresent in everyday life. In contrast, there has been a continuous decline in interest in technology among children and young people for years (Acatech, 2011; Tenberg, 2016; Acatech & Köber-Stiftung, 2021). Both the intensive use of technical systems in everyday life and the working world, and the declining interest in technical issues have not changed fundamentally in recent years. In addition, there are clear, largely unchanged gender-specific differences in career

preferences in the science, technology, engineering, and mathematics (STEM) fields (Acatech & VDI, 2009; Sachs, 1987; Bundesministerium für Bildung und Forschung, 2018; van Tuijl & van der Molen, 2016). School education therefore has the task of exploiting all possibilities to attract all the young people to technology subjects (Goreth, Krebs & Windelband, 2021).

The aim of Technology Education (TE) and/or Design and Technology Education (DTE) must therefore be to educate responsible citizens for a technologically dominated world (Pasternak, 2013). Given this aim, both TE and DTE should always be understood as part of general education (Ropohl, 2009) and should not be geared towards specific groups, such as boys. This is confirmed, among other things, by the choice of subjects in secondary schools in recent years (in Germany, for example: Statistisches Landesamt Baden-Württemberg, 2019; in Austria, for example: Sutterlüti, 2013). In contrast to Technology and Engineering Education (TEE) and the field of vocational training, this article focuses on Technology Education (TE), also known as Design and Technology Education (DTE). In German-speaking countries, there are a variety of terms for this general education subject (e.g., "Technik" = "technology", "Werken" = "crafts", "Technik und Design" = "technology and design") that are all distinct from the engineering sciences and are intended solely to provide pre-vocational orientation. However, the specific content of the subject (e.g., "Technik und Design" = "technology and design" in Austria) varies across the levels (primary, secondary level 1, and secondary level 2), though what they all have in common is that technical problems are solved while practicing rudimentary skills and procedures (creative design processes and the development of problem-solving skills, rather than the teaching of specialized engineering or vocationally qualifying content).

Education in a modern sense can promote the independence and self-determination of a person (Raithel, Dollinger & Hörmann, 2009), which will become increasingly important in relation to technology (Schlagenhauf & Wiesmüller, 2018). Dealing with technical issues is a central component of modern education and contributes significantly to preparing young people for the demands of today's life in society, work, and economy (Penning, 2023; Schlagenhauf & Wiesmüller, 2018; Stemmann & Lang, 2014).

Theoretical Background

Technology education fosters responsible citizens who can navigate a technology-driven world and help shape it (Goreth, 2020). In addition, people are given the tools to engage intelligently and thoughtfully with the world around them (National Academies of Sciences, Engineering, and Medicine, 2002), or to shape the world around them and solve problems (International Technology Education Association, 2007).

Problem-solving skills are now considered essential in order to be prepared for future developments and to solve problems creatively in unknown situations

(Organization for Economic Co-operation and Development, 2014). Need for Cognition (NfC) is essential in fostering problem-solving skills. This is because in an increasingly digitalized and automated everyday reality, the ability to solve practical problems creatively and purposefully is becoming particularly important (Koçoğlu & Kanadlı, 2025). Within STEM education, self-concept shows significant gender differences, often dependent on actual skill levels (Jann & Hupka-Brunner, 2020) that alongside parents and internships, have a clear influence on the choice of a technical profession or course of study (Brämer, 2019; Acatech, 2011).

The following section discusses aspects of learning (creativity, problem-solving, motivation) and the Need for Cognition (NfC) in the context of technology education. Specifically, in addition to personality traits and technical socialization to what extent can NfC also be considered an influencing factor in Technology Education? While the construct of technical socialization used here, in the strict sense, aligns with the German-speaking approach, which emphasizes technical interest and technical experiences, describes how people are introduced to technical activities and objects through family, and leisure time, and is distinguished from technological socialization, the NfC is regarded as a construct that describes an individual's stable intrinsic motivation to engage in and enjoy cognitively demanding thinking and problem-solving activities. Both are essential aspects of Technology Education.

Personality Traits (BIG-5)

The Five Factor Model (FFM), often referred to as the Big Five, is a widely accepted psychological framework designed to comprehensively describe human personality through five broad dimensions: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. By measuring these distinct traits, the model maps an individual's enduring behavioral patterns, emotional tendencies, and interpersonal styles. From an educational perspective, administering the FFM allows educators to identify student learning styles, predict academic performance (i.e., high conscientiousness strongly correlates with academic success) and anticipate potential behavioral challenges. These insights can then be used to tailor instructional methods, develop targeted socio-emotional interventions, and provide instructional strategies to support a student's natural strengths and dispositions.

The interaction of the five dimensions, which can vary in intensity but are always present, represent individual behaviors and experiences (Gerlitz & Schupp, 2005). In English-speaking countries, the acronym OCEAN is used as a mnemonic to remember the five factors, which are synonymous with the German psychological terms (Neyer & Asendorpf, 2018). Based on the work of Neyer & Asendorpf (2018), these five dimensions can be described as:

Openness to experience encompasses characteristics such as intellectual curiosity, artistic sensibility, and creativity and is positively related to intelligence and education.

Conscientiousness, in contrast, is characterized by a sense of order, perseverance, and reliability.

Extraversion is characterized by excitability, sociability, a high level of activity, and low inhibitions.

Agreeableness is reflected in friendly, helpful, and warm behavior toward others.

Neuroticism describes emotional instability characterized by nervousness, anxiety, and mood swings.

Relevant to Technology Education, a large-scale study of personality profiles in 263 occupations (Anni et al., 2025) showed moderate differences in the five-factor model of personality for work-oriented, manual-technical occupations (e.g., tailor, mechanic, shoemaker, roofer, painter, etc.). On average, these occupational fields scored below average to average on the dimensions of openness and extraversion, which may reflect a stronger orientation toward practical, proven, and regulated working methods. The scores for the remaining Big Five personality dimensions were predominantly within the overall average range. Research conducted by Feist (1998) demonstrated that personality traits such as openness to experience, conscientiousness, and extraversion are linked to creativity, problem-solving ability, motivation to learn, and interest in technology, and are therefore highly relevant to the teaching of technical subjects. In general, creative people are more open to new experiences, less conventional and less conscientious, more self-confident, more self-accepting, more goal-oriented, more ambitious, more dominant, more hostile, and more impulsive. In light of such findings, Technology Education should be well-positioned to promote technical socialization by instructionally incorporating openness and extraversion as integral elements of design, creativity, and problem-solving.

Technical Socialization

Technical socialization describes "how people become familiar with technology from early childhood through adolescence, vocational training, and university studies to their careers" (Acatech & VDI, 2009, p. 25, translated by the author). Acatech—the German Academy of Science and Engineering (Deutsche Akademie der Technikwissenschaften)—and the Association of German Engineers (Verein Deutscher Ingenieure, VDI) are among the most important German institutions dedicated to promoting science, engineering, and Technology Education. "Successful technology socialisation, i.e., obtaining an early understanding of the functions, potential and opportunities of technology, and the risk it poses, begins at home. By promoting fun and curiosity through a playful, experimental approach to technology and natural science, it is possible

to awaken an interest in technological matters while engendering greater openness toward technology" (Acatech & VDI, 2009/2010, p. 9). The parental home, kindergarten, and school are key locations where technical socialization takes place. However, friends and the media may also exert a formative influence on interest in technology (Acatech & VDI, 2009/2010). When examining technical socialization, it is particularly relevant to consider the extent of technical and scientific engagement in childhood, as interest and cognitive openness toward technical and scientific phenomena are known to develop at an early age (Acatech & VDI, 2009).

The research questionnaire administered by the Nachwuchsbarometer der Technikwissenschaften, used various items to assess the technical socialization of schoolchildren, students, engineers, and scientists (N = 12,846) (Acatech & VDI, 2009). These items covered areas such as game and object references in the technical and scientific fields or parental support. Among the most prominent results generated from this survey research was that children rarely engage with questions of how things work in everyday technical situations. Students interested in technology reported more frequent contact with technical games and objects than the general student population. Additionally, gender-specific differences in interest in technology and science were observed: male students scored higher in all areas examined (including aerospace engineering and electrical engineering) with the exception of medical technology and biology. In addition, further review of the literature revealed several studies that describe the influence of family, school, and extracurricular experiences on interest in technology, self-concept, and educational decisions, as well as those that address gender-specific socialization processes. Sociality is strongly associated with femininity and technology with masculinity (Faulkner, 2007). Since the consolidation of interests is usually complete by age 14 (Archer et al., 2010), early socialization is thus relevant to interest in technology in order to enhance students' academic success.

Need for Cognition

Need for Cognition (NfC) refers to a cognitive personality trait, defined as the stable tendency to actively seek out mentally challenging tasks and to enjoy engaging in them, as well as an individual's intrinsic motivation to engage in thought processes and resolve ambiguities quickly and permanently (Cacioppo & Petty, 1982). Cohen et al. (1955) originally defined NfC as "the need to structure complex situations in a meaningful, comprehensive way" (translated by the author) and associated it with intolerance of ambiguity. NfC thus encompasses two different dimensions: the need for structure (seizing: grasping onto the first plausible solution) and determination (freezing: locking onto that choice without further evidence) (Webster & Kruglanski, 1994; Liu et al., 2018). Technology Education is a subject where tasks usually provide complex problems, where seizing and freezing are common cognitive approaches novice

designers use to achieve problem solving when engaged in design-based learning, open-ended technological challenges, the engineering design processes, maker education, and authentic real-world problem-solving tasks.

People with high NfC scores find intellectual challenges satisfying and enjoy investing cognitive effort: they enjoy debates, problem solving and tend toward deep information processing (high elaboration) (Cacioppo & Petty, 1982). They actively seek information and reflect on it thoroughly. NfC explains systematic differences in people's engagement, particularly regarding cognitively challenging and strenuous activities (Cacioppo et al., 1996). In a school context, students with high NfC also display more engagement when they perceive a task as challenging (Steinhart & Wyer, 2009). In line with this finding, NfC predicts an individual's ability and interest to learn, especially in more cognitively demanding learning environments (Colling et al., 2022). Technology Education is a subject where intellectual challenges and imposed cognitive demands (Wells, 2016) are prevalent, because of the ongoing, continuous need for planning, adapting, thinking and doing as integral elements of design-based learning.

While people with high NfC tend to engage in more in-depth analysis and reflection, people with low NfC prefer quicker, predefined solutions (Li & Browne, 2004). Goswami (2025) examined the link between NfC and artificial intelligence (AI): there was a significant negative correlation between NfC and the use of ChatGPT, while NfC had no significant influence on general attitude toward AI. It can be concluded that people with lower NfC tend to rely on AI to find quick solutions, while people with higher NfC, due to their reflective thinking, tend to question AI and approach it critically. There is a correlation between ChatGPT use and NfC of $r = -0.33$ (Goswami, 2025). The implication is that students with lower and higher NfC would approach and carry out designerly tasks differently in Technology Education.

Furthermore, individual differences in NfC are independent of gender, socioeconomic status (SES), or cultural background (Bergold & Steinmayr 2023; Bertrams & Dickhäuser 2010; Colling et al. 2022; Preckel & Strobel 2017). A meta-analysis by Liu & Nesbit (2023) examined how high NfC scores affect learning performance, creativity, and problem-solving skills. Their results found there was an average correlation of $r \approx 0.20$ between NfC and academic performance indicators, with this correlation tending to be stronger among older or more advanced learners. Matthes et al. (2025) found that NfC is a positive predictor of academic interest, but that interest itself is not a predictor of high levels of NfC. In other words, individuals with high NfC often achieve better academic results, not only because they may be more cognitively gifted, but because their need to think has an independent positive influence. Interestingly, learners with high NfC show increased effort and engagement, especially when they expect a task to be difficult or demanding. They are less deterred by challenging tasks and approach them with greater commitment. Accordingly,

their learning gains benefit significantly from high NfC, especially in cognitively demanding learning environments, e.g., when dealing with complex problems or higher academic requirements (Liu & Nesbit, 2023).

Another correlation between high NfC and academic performance points to a particular development of skills in problem-solving processes (Strobel et al., 2024). People with high NfC actively seek solutions and explanations. They benefit from their critical perception as effective problem solvers and are particularly interested in why a problem solution works. This can provide insights for future problem-solving activities and the development of learning strategies, which can consequently lead to more effective performance (Coutinho et al., 2005).

In summary, the literature shows that individuals with high NfC prefer complex cognitive challenges, take a more analytical approach, and persevere more in tackling demanding tasks (Cacioppo & Petty, 1982; Cacioppo et al., 1996). These characteristics are particularly significant given technology-, engineering-, and design-oriented learning environments impose cognitive demands on learners, underscoring the relevance of this construct to the present study. This is especially evident when considering the overarching subject-area aim of developing problem-solving competence, along with its curricular objectives.

Method

Research Design

Enjoyment and engagement in cognitive tasks are reflective of the Need for Cognition (NfC) and considered to have an influence on problem-solving skills and creativity. Taking this into account, the current study focused on assessing the influence of key factors on students' NfC. To do so, the study employed a quantitative, non-experimental cross-sectional survey design. Data were gathered using an adapted composite questionnaire comprised of validated Likert-scale items selected to measure the influence of key factors on students' NfC. Results of data analysis provide insights into key influential factors such as the participants' experience with technology (e.g., previous experience with technical games and objects, interest in technology and science fostered by the family environment) and personality traits (BIG-5 personality factors) with the goal of identifying correlations with Need for Cognition.

The research questions guiding this study were:

1. What correlations can be revealed between the Need for Cognition (NfC), experienced technical socialization, and the Big Five personality traits among students?
2. To what extent do these correlations differ by gender?

The following hypotheses were tested:

H1. Cognitive need is influenced by experienced technical socialization (the degree of technical play and object references and parental support) as well as personality traits.

H2. Male students show higher values in experienced technical socialization (both in terms of technical play and object references and in terms of parental support) than female students, as measured by self-assessments.

H3. There is no difference in the extent of Need for Cognition between male and female students.

In answering the research questions and addressing the hypotheses, this study aims to:

- provide insights for teachers on how to design instruction for technology classes taking into account students' NfC,
- use the results to encourage teachers to develop instructional strategies that intentionally promote cognitive demand.

Instrumentation

Data were collected as part of the DIGIdat research project, which focused on the subjective perception of indoor air quality at various measurement time points. The students generated a personal ID at the beginning of the project. This ensured anonymity while simultaneously allowing the responses to be assigned to the various measurement times and the aggregated test duration to be distributed across the lessons. One subproject involved identifying the students' interests and technical backgrounds.

For the present study, the questionnaire was developed to include a socio-demographic section to determine age, gender, and first language. In addition, the questionnaire contains questions on technical socialization based on the questionnaire items from Acatech and VDI (2009), which were used for surveys as part of a report in the Nachwuchsbarometer Technikwissenschaften (N = 12,846). Twelve items on *play and object references*, two items on *parental support of interest*, and twelve items on the *image profile of technical and scientific professions* among students were selected for this purpose (Acatech & VDI, 2009). Various tried-and-tested questionnaire items already exist for the collection and evaluation of personality factors based on external or self-perception (Neyer & Asendorpf, 2018). The Big Five Inventory (BFI) versions by Gerlitz and Schupp (2005) may be used freely (Neyer & Asendorpf, 2018). The Big Five Inventory-Short Form (BFI-S) developed by Gerlitz and Schupp (2005) was used to examine the personality factors of the students. The test for measuring enjoyment and engagement in cognitive tasks (Need for Cognition; NfC for short) is based on a test developed by Cacioppo & Petty (1982), in which 45 test items on a 9-point Likert scale were tested on a homogeneous

group (Cacioppo & Petty, 1982). The tendency to experience positive feelings towards conscious analytical activities is distinct from cognitive abilities and has a one-dimensional structure. The test, which was adapted into German by Preckel (2014), contains items, some of which were revised and validated with 20 students using a 5-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree"); it also exhibits a unidimensional structure (Preckel, 2014).

The selection of items and the development of the NfC Influence Questionnaire (NfC-IQ) instrument were carried out by an interdisciplinary team of four experts from the DIGIdat project (2 educational researchers, 1 pedagogical-content researcher, 1 subject-specific researcher). The item selection process took place in several steps. After the expert team reviewed potential instruments, their use was discussed and subsequently selected based on possible correlations derived from theory. The structure of the NfC-IQ was comprised of the following items:

- Need for Cognition – 19 items: 5-point Likert scale (1 = 'Strongly disagree' to 5 = 'Strongly agree') (Cronbach's $\alpha = 0.80$, with decoded items), example item: I enjoy coming up with solutions to problems.
- Big Five Inventory-Short Form – 15 items: 5-point Likert scale (1 = 'Does not apply at all' to 5 = 'Applies completely') (Cronbach's $\alpha = 0.69$ across all characteristics, which is within the expected range for the short scale, given the various dimensions), example item: I am someone who completes tasks effectively and efficiently.
- Acatech/VDI (technical socialization/play and object references – 12 items: 6-point Likert scale (1 = 'Does not apply at all' to 6 = 'Applies completely') (Cronbach's $\alpha = 0.90$), example item: How often do you engage with these things?
- Acatech/VDI (technical socialization/parental encouragement – 2 items: 6-point Likert scale (1 = 'Does not apply at all' to 6 = 'Applies completely') example item: My family encourages my interest in technology.
- Acatech/VDI (characteristics of technical professions) – 12 items: 6-point Likert scale (1 = 'Does not apply at all' to 6 = 'Applies completely') example item: In your opinion, what characteristics do technical professions have?
- Sociodemographic data – 3 items: (age, gender, first language)

The NfC-IQ was administered via the online platform soscisurvey to students in schools from the DIGIdat project who voluntarily completed the questionnaire. The NfC-IQ questionnaire took approximately 15 minutes to complete.

Data analysis was primarily performed using t-tests for independent samples and one- or two-factor analyses of variance (ANOVA) to test the hypotheses. The questionnaire mainly contained Likert scales, which allows for

the calculation of means and standard deviations as well as the comparison of groups using t-tests and ANOVA. The t-tests were used to test mean differences between two independent groups, for example, in the analysis of gender-specific differences. For comparisons of more than two groups, for example regarding the predictor of Need for Cognition, one-way analyses of variance (ANOVA) or correlation analyses between variables were performed. The statistical analyses were conducted with a significance level of $p < .05$.

Procedures

Participants

Prior research indicates interests and career-related orientations largely stabilize by around age 14 (Archer et al., 2010). Furthermore, the period prior to age 14 is considered particularly significant for the development of technical interests and socialization-related attitudes. Thus, students in lower and upper secondary school from a total of ten schools in Tyrol were targeted for participation in this survey research. Participants were drawn from both middle schools and academic high schools, as well as one higher school. Participating classes were predominantly eighth grade. Moreover, taking into account prior research by Archer et al., this study deliberately focused on students aged 12 to 13, as this age group represents a pivotal phase of Technology Education in lower secondary schools of Austria. At this age, classroom instruction increasingly focuses on technical problem-solving, design processes, and fundamental technical and creative skills in accordance with curriculum guidelines.

Table 1

NfC Participants: Student Volunteers per DIGIdat School Type

Code	DIGIdat School Type	# NfC Volunteer Participants
	Unclassified	16
AHS	Academic High School	73
AHS	Federal Academic High School I	23
AHS	Federal Academic High School II	77
AHS	Federal Academic High School III	63
BHS	Higher Technical School	67
MS	Middle School I	129
MS	Middle School II	71
MS	Middle School III	59
MS	Practical Middle School	23
MS	Middle School IV	13

Before the project began, the DIGIdat project leadership selected the participating schools, taking care to assemble a sample that was as heterogeneous as possible. Schools with different structural conditions (transit traffic vs. no transit traffic through the Alpine valley) and varying levels of equipment (ventilation system present vs. no ventilation system present) were considered. In addition, care was taken to ensure a balanced ratio between urban and rural schools as well as among different types of schools (Table 1). The goal of this selection was to reflect the diverse perspectives and conditions of the participating schools with regard to indoor air quality. Participation in the research project was voluntary and not mandatory for the schools.

NfC-IQ Questionnaire Administration

Administration of the NfC-IQ was conducted via the SoSciSurvey platform. Administration took place over a 1-year period between spring 2023 and 2024 during school hours and was supervised on-site by the respective teachers. Participation was voluntary, and those students choosing to participate completed the questionnaire independently on tablets or iPads.

Prior to questionnaire administration, the Ethics Committee of the Lehrerinnenverbund West of the Universities was asked to raise any potential concerns. All data collected were completely anonymized and had no influence on grades assigned by teachers. Questions regarding cultural backgrounds were deliberately not included. The DIGIdat research project (SPSC_01_154) is funded and monitored by the BMBWF (Federal Ministry of Education, Science, and Research) through the Citizen Science Sparkling 2.0 program. The consent forms from the legal guardians of all participants were obtained.

Collected data were prepared for statistical analysis and subsequently analyzed using appropriate methods. The goal of data preparation was to prepare the collected variables for statistical analysis and to create composite scales for the constructs under investigation from the items used. The statistical analysis was performed using IBM SPSS Statistics 32.0 software.

All available data sets were included in the present study. Given data collection for the DIGIdat research project took place over several rounds of questionnaire administrations, complete data sets were not available for all participants at every measurement point in time. However, because the present study focused on the aggregated scale scores of the individual constructs, even incomplete data sets could be included in the analysis. Therefore, all available data on the relevant items were used for the analysis.

Prior to the statistical analysis, negatively worded items on individual scales were recoded. This was necessary because, for these items, a high level of agreement does not automatically reflect a high level of the respective construct. For example, a high level of agreement with a negatively worded Need for Cognition item such as “I don’t enjoy thinking” would indicate a lower level of Need for Cognition. To ensure that all items within a scale can be interpreted

consistently, these statements were reversed accordingly. The recoding affected a total of four items on the BFI-S form and eight items on the Need for Cognition questionnaire.

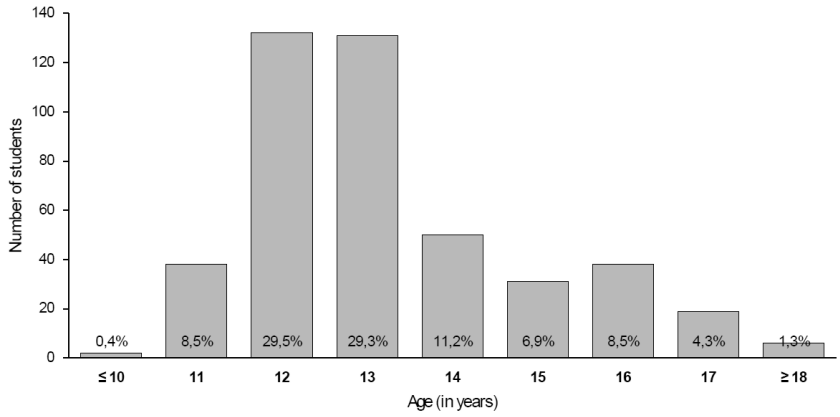
Results

Participant Demographics

Participants in this study (N = 614) ranged in age from 10 to 18 years of age (Figure 1), with the largest portion being those aged 12 to 13 (≙ 58.8%). The distribution of males and females was 56.3% and 43.7% respectively, and among them German was the predominant first language (77.7%).

Figure 1

Age distribution of student participants

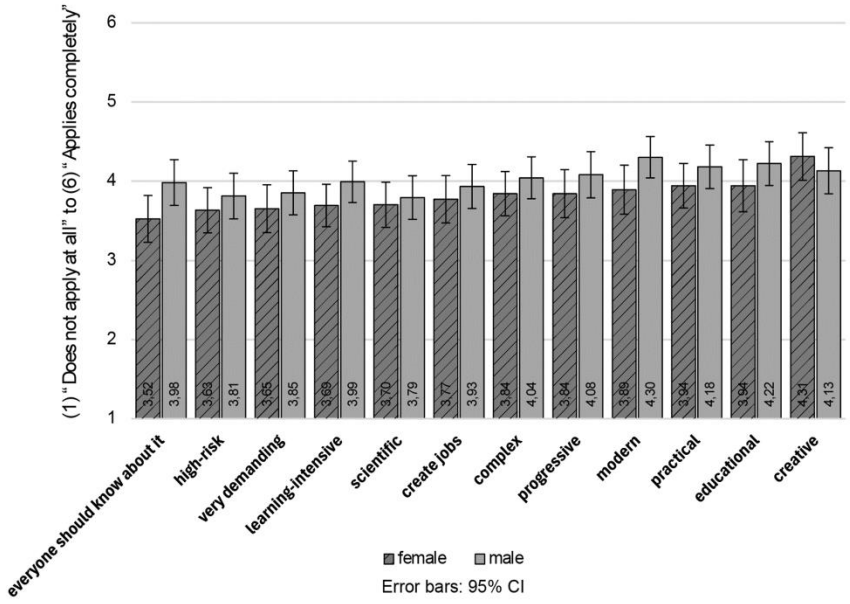


Characteristics of Technical Professions

Items assessing characteristics of professions (Figure 2) indicate relatively homogenous responses between genders. It can be noted that, on average across both genders, the lowest scores are found in the categories everyone should know about it (M = 3.84, SD = 1.42) and high-risk (M = 3.75, SD = 1.38) and the highest scores in educational (M = 4.13, SD = 1.41) and creative (M = 4.22, SD = 1.41). Between these extremes are scores such as complex (M = 3.99, SD = 1.30) or create jobs (M = 3.91, SD = 1.38).

Figure 2

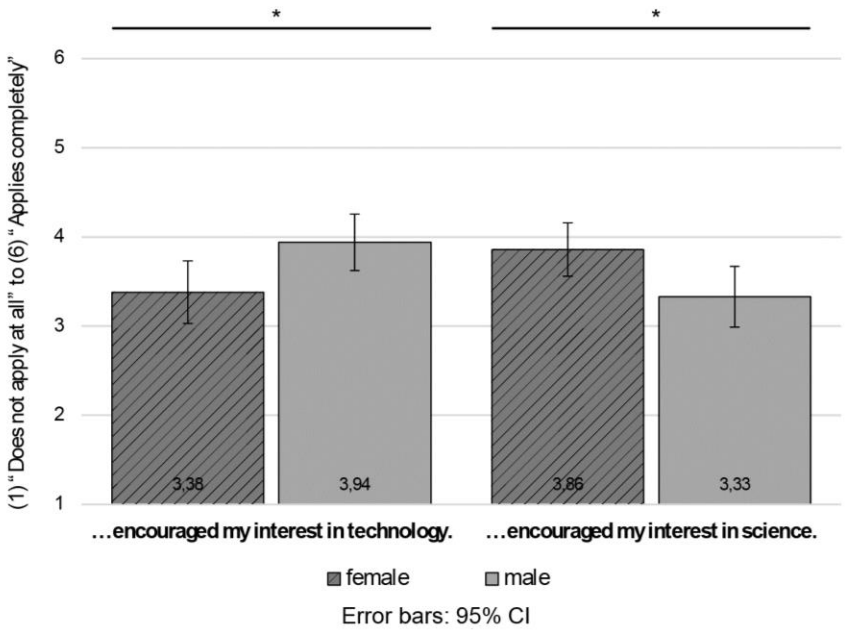
Characteristics of the Profession (six-point Likert scale from 1 = "Does not apply at all" to 6 = "Applies completely")



Parental support for the profession (Figure 3) is somewhat gender-dependent. The data indicate that female participants tend to be more supportive of science (M_{Girls} = 3.86, SD = 1.22) than their male counterpart (M_{Boys} = 3.33, SD = 1.72) at $t(158) = 2.27$; $p < 0.05$; $d = 0.37$), while male participants are more likely to be encouraged towards technology (M_{Boys} = 3.94, SD = 1.61) than female participants (M_{Girls} = 3.38, SD = 1.44) at $t(163) = -2.26$; $p < 0.05$; $d = -0.36$).

Figure 3

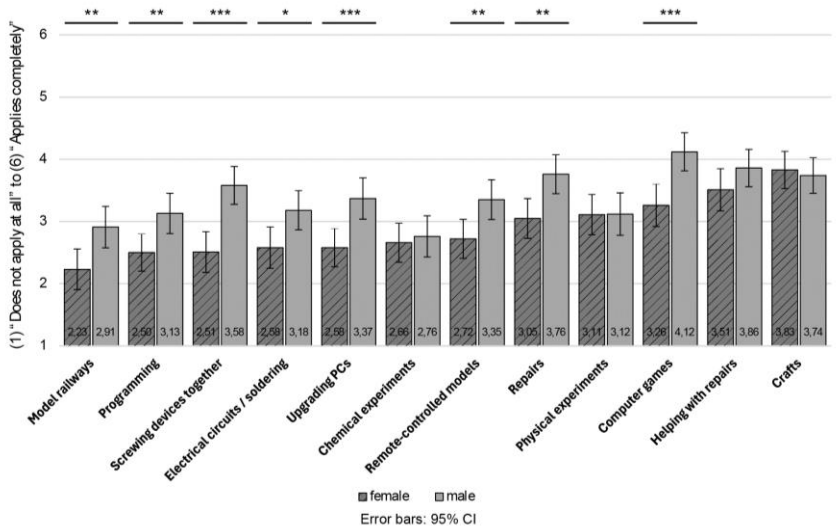
Parental support for students (six-point Likert scale from 1 = "Does not apply at all" to 6 = "Applies completely")



The difference in parental support for students is also evident in specific play and object references (Figure 4). While crafts, physical experiments, chemical experiments, and helping with repairs show only descriptive differences, the situation is different when it comes to technical and IT-related references.

Figure 4

Technical Socialization through Play and Object References (six-point Likert scale from 1 = "Does not apply at all" to 6 = "Applies completely")

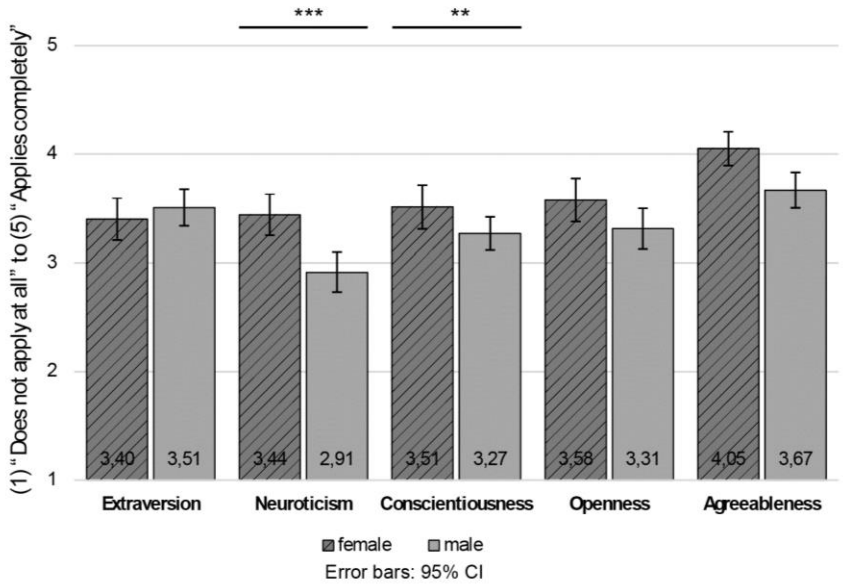


During their childhood, male students were more likely to engage in activities such as model railways (M_{Boys} = 2.91, SD = 1.74), electrical circuits/soldering (M_{Boys} = 3.18, SD = 1.66), assembling devices (M_{Boys} = 3.58, SD = 1.60) and repairs (M_{Boys} = 3.76, SD = 1.70) than female students (M_{Girls} = 2.23, SD = 1.34, M_{Girls} = 2.58, SD = 1.36, M_{Girls} = 2.51, SD = 1.39 & M_{Girls} = 3.05, SD = 1.32) at $t(160) = -2.87$; $p < 0.01$; $d = -0.45$, $t(168) = -2.45$, $p < 0.05$; $d = 0.39$, $t(169) = -4.54$, $p < 0.001$; $d = 0.72$ & $t(158) = -2.45$, $p < 0.01$; $d = 0.49$ (Figure 4).

Figure 5 depicts analyses of personality trait data collected from the Big Five Inventory-Short Form (BFI-S). The results show that female students score higher than male students in the areas of neuroticism (M_{Girls} = 3.44, SD = 0.86) and conscientiousness (M_{Girls} = 3.51, SD = 0.91) compared to male students (M_{Boys} = 2.91; SD = 0.88 & M_{Boys} = 3.27, SD = 0.73) at $t(168) = 3.92$; $p < 0.001$; $d = 0.60$, $t(165) = 1.91$, $p < 0.01$; $d = 0.30$.

Figure 5

BIG-5 Personality Traits (five-point Likert scale from 1 = "Does not apply at all" to 5 = "Applies completely")



In addition, there are no significant differences in other areas, such as Openness (M_{Girls} = 3.58, SD = 0.89, M_{Boys} = 3.31, SD = 0.88). The mean value for the Need for Cognition dimension is for the female students (M_{Girls} = 3.20, SD = 0.55) and for the male students (M_{Boys} = 3.13, SD = 0.55). This results in a range of R = 3.47, and the results can be assumed to be normally distributed (kurtosis = 0.74 & skewness = 0.27).

Results from an ANOVA (Table 2) shows that neither parental support experienced in science and technology (technical socialization) nor the play and object references (technical socialization) nor gender and age have a significant influence on the Need for Cognition. Within the personality traits, it can be seen that openness to experience (open-mindedness) has a significant influence on the Need for Cognition $F(118) = 1.56$, $p < 0.05$.

Table 2

Results of an ANOVA (Need for Cognition)

Predictor	*df*	*F*	*p*
Age	78, 219	0.92	.661
Gender	79, 223	0.86	.774
Parental support: Interest in technology	49, 49	0.89	.659
Parental support: Interest in science	49, 47	1.11	.359
Openness	52, 66	1.55	.045
Conscientiousness	54, 66	1.17	.274
Extraversion	53, 69	1.25	.190
Agreeableness	52, 69	1.09	.370
Neuroticism	54, 69	0.78	.826
Technical socialization: Game and object references	50, 52	0.82	.764

Discussion

Problem-solving competence is widely regarded as one of the central educational goals of Technology Education or Design and Technology Education because it enables learners to participate responsibly in a technology-driven society (Organization for Economic Co-operation and Development, 2024). Against this background, the present study investigated whether students' NfC is associated with technical socialization and personality traits.

The first important finding concerns technical socialization. Consistent with previous studies (Acatech & VDI, 2009; Archer et al., 2010), boys reported significantly more technical play experiences, object-related activities, and parental encouragement in technology than girls. These results confirm that gendered patterns of technical socialization remain stable despite numerous initiatives promoting girls in STEM over the last decades. The absence of gender differences in NfC is equally noteworthy, because girls reported substantially lower levels of technical socialization.

A second and more important contribution to Technology Education concerns the role of NfC. In contrast to widespread assumptions that stronger technical experiences automatically foster cognitive engagement (Acatech, 2011), neither technical socialization nor parental encouragement significantly predicted NfC. Instead, openness to experience emerged as the only significant predictor. This finding suggests that NfC represents a relatively independent

disposition that cannot simply be developed through increased exposure to technical artefacts or technical activities.

Perhaps the most important contribution of this study lies in the finding that openness to experience—but not technical socialization—predicts NfC. From a Technology Education perspective, this indicates that NfC represents a distinct construct that cannot simply be explained by previous technical experiences. The finding that openness to experience predicts NfC also has implications for instructional design. Technology education should not only provide opportunities for hands-on activities but should deliberately create learning environments that stimulate curiosity, exploration, creativity, and reflection (Goreth, Krebs & Windelband, 2021). Design-based learning, open-ended technological challenges, engineering design processes, maker education, and authentic real-world problem-solving tasks appear particularly suitable because they require students to evaluate multiple solution pathways rather than reproduce predefined procedures. Such approaches may strengthen students' willingness to invest cognitive effort even if NfC itself is considered a relatively stable personality-related disposition.

Conclusion

From a theoretical perspective, the juxtaposition of technical socialization and NfC provides valuable insight. Specifically, technical socialization explains how learners become familiar with technology through family, school, peers, and everyday experiences, whereas NfC describes an individual's intrinsic willingness to engage with cognitively demanding problems. Considering both constructs simultaneously provides the opportunity for researchers in Technology Education research to differentiate between external learning opportunities and internal NfC. Doing so would contribute to a more comprehensive understanding of why learners with similar technical experiences may nevertheless approach technological problem-solving differently.

The findings also provide important implications for educational practice. Rather than focusing exclusively on increasing students' exposure to technology, teaching should deliberately promote learning environments that stimulate curiosity, intellectual exploration, creativity, and sustained reflection.
Finally, the study highlights several promising directions for future research. Longitudinal investigations are needed to examine how NfC develops throughout school education and how it interacts with technical experiences over time. Integrating these perspectives could contribute to more comprehensive explanatory models of learning in Technology Education.

Limitations

Several limitations should be considered when interpreting the findings. First, the study is based on a regional sample of secondary school students from Tyrol (Austria). Although the sample size is substantial, the educational context,

curricular framework, and cultural characteristics may differ from those in other countries. Consequently, the transferability of the findings to other educational systems should be made with caution.

Second, the study employed a cross-sectional design, which does not allow causal conclusions. While openness to experience was identified as a significant predictor of Need for Cognition (NfC), it cannot be determined whether personality characteristics promote cognitive motivation or whether repeated engagement with cognitively demanding learning environments influences personality-related dispositions over time. Longitudinal studies are therefore needed to better understand developmental trajectories.

A further limitation concerns the measurement approach. Technical socialization was assessed using retrospective self-reports about childhood experiences and parental encouragement. Such measures may be influenced by memory effects or subjective perceptions. Likewise, the study focused on motivational dispositions rather than actual technological competence, engineering design performance, or observable problem-solving behavior. Future studies should therefore combine validated motivational scales with performance-based assessments and authentic design tasks.

Conflict of Interest Statement

The authors have no relevant financial or non-financial interests to disclose.

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