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ICT interest and self-concept as determinants of Swiss adolescents' vocational choices

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Abstract
This study examines whether adolescents' interest and self-concept regarding information and communication technologies (ICT) affect their subsequent career paths through the selection into different vocational education and training (VET) programs. Drawing on Eccles' situated expectancy value theory and related theories, we argue that ICT interest and self-concept should influence adolescents' vocational choices, possibly contributing to occupational gender segregation regarding ICT. Using longitudinal data from the TREE2 study (Transitions into Education and Employment) on 1,995 Swiss adolescents transitioning into firm-based VET, we find strongly gendered patterns. ICT interest predicts selection into occupations with greater intensity of basic and advanced ICT use, but this positive association is driven entirely by girls. In contrast, ICT self-concept significantly predicts ICT use intensity in future occupations only among boys. Selection into ICT specialist occupations is associated exclusively with adolescents' ICT self-concept rather than their ICT interest, questioning whether girls' lower average ICT interest represents a relevant barrier for entry into ICT specialist occupations in the context of VET. Our findings emphasize that ICT are an important content domain of adolescents' vocational choices today and highlight how gendered interests and self-concepts towards ICT perpetuate occupational gender segregation.

Keywords Career choice, Gender segregation, ICT interest, ICT self-concept, Occupations, Task content, Technology

Introduction

Interests and self-concepts regarding domains like mathematics, reading, or science are well-established as important determinants of vocational choices in adolescence (Volodina and Nagy 2016). Consequently, gender differences in interests and self-concepts regarding mathematics and science are a central and longstanding explanation for the continuing female underrepresentation in certain professions (Su et al. 2009; Kriesi and Imdorf 2019; Kang et al. 2021), particularly in STEM fields (Science, Technology, Engineering, and Mathematics). This underrepresentation contributes to persistent gender inequalities in labor market outcomes such as wages and prestige (e.g., Bol and Heisig 2021; Combet 2024). In this study, we focus on a particular domain which has received

limited attention in the vocational choice literature to date despite its great and ever-growing importance in modern labor markets (Fernández-Macías et al. 2023): information- and communication technologies (ICT).

Over time, the use of ICT has become an integral part of the task profiles of many occupations across sectors. The use of computers in general, but also the use of specialized, highly technical tasks like programming, is widespread in and outside the ICT sector. A robust economic literature finds that ICT-related skills are in high demand and associated with high wage premia (e.g., Atasoy et al. 2021; Falck et al. 2021). Graduates from vocational education and training (VET) programs that include ICT skills in their curricula are more likely to find a qualified job (Kiener et al. 2022) and to experience a smoother school-to-work transition. However, there is relatively little research examining the psychosocial processes guiding adolescents' occupational choices within VET systems (that is, their vocational choices) in relation to ICT. Previous research is largely restricted to studies investigating the effects of interests and self-concepts in predicting the choice of or the aspiration to select computer science as a subject in secondary or tertiary education (e.g., Sáinz and Eccles 2012).

Our central research interest lies in understanding whether and how ICT interest and self-concept influence adolescents' choice of different VET occupations. Building on established theories of vocational choices like the (situated) expectancy-value theory of achievement motivation (Eccles et al. 1983), we argue that, similar to other domains like mathematics and science, the increased use of ICT at work in recent decades may have led ICT interest and ICT self-concept to being important determinants of vocational choices in adolescence. Individuals faced with the need to choose between occupational alternatives may consider the role of ICT in occupations both within and outside the ICT sector.

This influence may come about in two related, but conceptually different ways: First, when choosing a VET occupation, adolescents may consider the intensity of using ICT as tools that varies between occupational alternatives (Fernández-Macías and Bisello 2022). For example, adolescents may consider to what extent they would enjoy using a computer for several hours a day at work, and whether they would feel confident in performing tasks that require more advanced ICT-related skills. Second, in addition to the first type of influence, ICT interest and self-concept are likely to influence whether adolescents seriously consider working in the ICT sector specifically (e.g., as ICT specialists like application programmers, platform developers, or media technicians). Here, ICT are not only used intensively as tools but represent the central content domain of an occupation. ICT interest and self-concept may affect vocational choices in adolescence in both ways.

For our empirical analyses, we draw on a sample of Swiss compulsory school leavers transitioning to dual VET, a consequential first career choice for a majority of Swiss adolescents. We link this information on adolescents' vocational choices to a novel taxonomy that quantifies the intensity of ICT use across different occupations in Europe (Fernández-Macías and Bisello 2022). Our findings are relevant to both research and career counseling practice, as they enhance understanding of the underexplored processes around (gendered) choices of occupations with regard to the ICT domain, which may work differently compared to other domains such as mathematics or science. Our analyses have important implications for gender inequalities in modern labor markets,

particularly regarding female underrepresentation in the ICT sector (European Institute for Gender Equality 2018). We therefore investigate whether ICT interest and ICT self-concept affect vocational choices differently depending on gender, as suggested by previous research, and to what extent girls' (expected) lower average interests and self-perceived abilities towards ICT explain their (expected) lower likelihood of selecting occupations requiring a more extensive use of advanced ICT.

Theoretical background

Vocational choice and the importance of person-environmental alignment

It is well-established that when choosing an occupation, individuals generally strive for a good subjective fit between their personality and the features of their future work environment (Holland 1959; Caplan 1987). The Person-Environment (P-E) fit concept has been central to vocational psychology, particularly in vocational choice theories (for an overview see: Brown and Lent 2005). This concept suggests that alignment between individual characteristics and the occupational environment is associated with greater occupational satisfaction and success (Wilkins and Tracey 2014) and improved emotional well-being and general life satisfaction beyond the occupational context (Nägele and Neuenschwander 2015; Gander et al. 2020). Within this P-E fit tradition of career choice research, both interests (Holland 1959, 1997; Gottfredson 2005; Lent 2013) and self-concepts (Eccles et al. 1983; Betz 1994; Lent 2013; Eccles and Wigfield 2020) are considered important predictors of the fit between individuals and work environments (Brown and Lent 2013; Volodina and Nagy 2016).

Interests can be defined as outwardly directed preferences that influence an individual's attention and engagement with a particular activity or subject area (Morgan et al. 2019). When individuals are interested in the content of their work, they report higher satisfaction, better performance, and greater perseverance at work (Dawis 2005; Nye et al. 2021). Vocational interests in particular domains have thus long been a foundational pillar of career counselling (Morgan et al. 2019) and work and career-focused research (Dawis 2005).

Self-concepts on the other hand, refer broadly to an individual's perception of themselves. As a mental model, they encompass all self-related evaluations, including assessments of abilities, traits, and values. Self-concepts can be differentiated into ability self-concepts, self-efficacy, and expectancy of success (Mohr 2021). Due to their conceptual similarity however, these constructs are often difficult to distinguish empirically (see Marsh et al. 2019 for details). In the context of empirical research on vocational choices, self-concepts are typically understood as the level of self-perceived abilities in a certain (academic) domain, like mathematics, reading, or science (Eccles and Wigfield 2020).

The development of interests and self-concepts is shaped by external factors like socialization and gendered stereotypes (Watt 2006). Social influences also shape subjective views of different occupations, contributing to a limited range of career options that individuals seriously consider (Gottfredson 2002, 2005). Consequently, domain-specific interests and self-concepts significantly mediate the impact of achievement and gender on career-related choices. They do so by shaping how individuals perceive their own abilities and which value they place on different career paths (Eccles et al. 1983; Lent et al. 1994; Volodina and Nagy 2016; Eccles and Wigfield 2020).

Domain-specific interests and self-concepts in Eccles' SEVT

The (situated) expectancy-value theory of achievement motivation (SEVT; Eccles et al. 1983; Eccles and Wigfield 2024) aims to identify the major categories of social and psychological influences on people's achievement-related choices, which includes the choice of occupations. It was originally developed to explain the cultural phenomenon of why girls were less likely to choose STEM courses or careers (Eccles and Wigfield 2024). The SEVT serves as our primary theoretical framework for the discussion of ICT-related vocational choices in the following sections, providing a systematic account of how domain-specific interests and self-concepts, along with their associated gender differences, influence occupational choices during adolescence.

The SEVT particularly emphasizes two core components: subjective task value and expectancy of success. *Subjective task value* refers to the value individuals assign to performing a task (like completing a VET program), which consists again of four different components: attainment value (the importance of doing well on a task), intrinsic value (the enjoyment derived from engaging in a task), utility value (the fit of a task with future plans and goals) and cost, which includes required effort, emotional costs, and opportunity costs of performing a task (Eccles and Wigfield 2024: 5). In this study, we focus mainly on intrinsic value, because domain-specific interests, one of the two main concepts of our study, are typically understood as direct representations of intrinsic value in research on vocational choices (Eccles and Wigfield 2020).

Expectancy of success, on the other hand, is defined as "individuals' estimates of how well they would do in the near or far future on any specific task or activity" (Eccles and Wigfield 2024: 51). This expectation is influenced by a range of task- or activity-related beliefs, including goals, self-perceptions, and perceptions of the demands of tasks. In the context of vocational choices, self-concepts of abilities are particularly important, and therefore often used as a direct measure of expectation of success in applied research (Eccles and Wigfield 2024).

A major strength of the SEVT is its systematic integration of the socio-cultural perspective (Eccles and Wigfield 2020). According to the SEVT, gender stereotypes and the beliefs and behaviors of significant others, such as parents, peers, and teachers, shape how children and young adults interpret their achievement-related experiences. The interpretation and memory of these experiences ultimately affect children's subjective task values and expectancies of success. Depending on socio-cultural influences, similar experiences (e.g., a successfully passed exam) can be attributed very differently by children (e.g., "due to luck", vs. "due to skill"). This attribution process is often used to explain why girls and boys develop different ability beliefs in domains like mathematics, although they tend to perform similarly in standardized tests (Perez-Felkner et al. 2017). In line with the SEVT, mathematical self-concept and interest have been consistently found to strongly predict STEM career aspirations, and their predictive power tends to outweigh the predictive power of actual skill levels in mathematics (Sax et al. 2015; Eccles and Wang 2016; Watt et al. 2017).

The most important takeaway from the SEVT is that when adolescents are faced with the need to make a vocational choice (like choosing a VET program), they consider the tasks associated with different vocational options in a certain way: They anticipate whether they will be intrinsically motivated to complete these tasks on a daily basis, referencing their respective interest values, and whether they think they can successfully

complete these tasks with reference to their relevant domain-specific self-concepts. Hence, along with attainment value, utility value, and perceived cost, interest and self-concept regarding a certain domain can directly influence adolescents' choice behavior. Moreover, the SEVT suggests that the effect of self-concepts on choice behavior is partially mediated by interests (Volodina and Nagy 2016; Eccles and Wigfield 2020). In the following, we apply this framework to the ICT domain.

ICT interest and ICT self-concept as determinants of vocational choices in the Swiss VET system

Context of the present study

The context for the empirical analyses is Switzerland, a country with a strong tradition of VET. In Switzerland, VET gives access to over 240 different occupations, from low-skilled ones such as hairdresser, bricklayer or waiter to highly skilled ones such as commercial clerk, electrician or web and multimedia developers. Approximately two thirds of compulsory school leavers in Switzerland enter the vocational track typically lasting for three or four years (Gomensoro and Meyer 2021). Most school leavers enter firm-based vocational training programs which combine in-firm training (in general for three days of the week) and training at a vocational school (for the rest of the week). The participation of employers, often through organizations of work, such as chambers of commerce, aims to ensure that the skills taught align with employers' own needs, allowing for a smooth transition into the general labor market (Bonoli and Wilson 2019).

To start a firm-based vocational training program, the apprentice must find an apprenticeship position with a training company, with which the apprentice signs a contract. Unlike fully school-based education (whether general or vocational), where access conditions are clearly defined, the allocation of firm-based apprenticeship positions is scarcely regulated by the state. Companies select apprentices on a competitive basis that is similar to hiring employees in the general labor market. The selection process accounts for various characteristics of applicants, such as their educational outcomes (school grades, level of requirement of the attended lower secondary track, etc.), and individual characteristics such as motivation, interest in the occupation and relative tasks, personality, soft skills, age, etc., to assess their suitability for the job (Duc and Lamamra 2022). Many companies also request applicants to pass cognitive tests tailored to the challenges of the respective occupation (Imdorf 2018).

Particularly in strongly gender-segregated fields, companies may consider applicant gender when selecting apprentices (Imdorf 2018). Various motivations can influence this practice, including employers' assumptions about gender-specific abilities (e.g., physical strength), anticipated changes in team dynamics, and expectations regarding employee retention, as demonstrated in Switzerland's automotive repair industry (Imdorf 2012). Similar processes could occur in the male-dominated ICT sector, though we found no prior empirical studies in the Swiss context. However, experimental evidence indicates that unlike in Germany, the likelihood of receiving an interview invitation for apprenticeship positions in Switzerland does not vary by applicant gender, even in strongly gender-imbalanced occupations (Fernandes et al. 2023). In some cases, gender-based selection may even favor female applicants in male-dominated fields (Imdorf 2012). While evidence suggests some gender discrimination exist in Swiss hiring processes that

could limit female entry into ICT-intense occupations, the evidence for gender segregation stemming from differences in preferences is considerably stronger.

After obtaining a VET certification, some graduates enter tertiary education. Nevertheless, the Swiss labor market is marked by a strong link between VET and future occupations (Buchmann and Sacchi 1997; Hupka-Brunner and Meyer 2023). Hence, in the Swiss context, the transition from compulsory school to vocational training is particularly consequential for adolescents' future careers. Because occupations are strongly linked to certain VET programs, gendered choices of VET are hardly attenuated over the life course (Heiniger and Imdorf 2018). The high share of each cohort entering a firm-based training coupled with the tight link between entered VETs and future careers in the strongly segmented Swiss labor market makes this a well-suited case for our study. The competition for apprenticeship positions at companies to some extent attenuates the empirical leeway for interests and self-concepts to influence selection into firm-based VET, as not all applicants will be granted access to their preferred occupation.

ICT as an underexplored domain of vocational choice

One of the most visible consequences of computerization and automatization during the late 20th and early 21st century is the overall increase in the use intensity of ICT across the labor market, a trend still ongoing to date. The use of computing devices (personal computers, but also other devices) and software can be understood as the use of specific tools to perform some kind of task (Fernández-Macías et al. 2023). On the one hand, this overall increase of ICT use at work can be attributed to changing ways of performing tasks within existing occupations, i.e., certain tasks which used to be performed "by hand" are now performed using ICT. On the other hand, technological change has created entirely new occupations and tasks focused on ICT-related products and services, often connected to a strong specialization in programming and software.

Previous empirical research on vocational choice behavior related to the ICT domain has mostly focused on the choice of rather specific secondary or tertiary level study programs such as computer science (e.g., Sáinz et al. 2012; Beyer 2014). This narrow focus is related to the shortage of ICT specialists (e.g., computer scientists and programmers) across developed countries, which can affect economic development on a national scale (Düll 2020). But it also neglects the fact that the question of what kind of role the use of ICT will play in their future occupation may affect adolescents' vocational choices directly, i.e., the choice of a vocational training program, or a regular occupation after completing secondary or tertiary education. Moreover, computer use at work is related to lower routine task content and ultimately, objectively higher job quality (Menon et al. 2020) and higher job satisfaction (Minardi et al. 2023). Occupations where computers are used also tend to grow in terms of worker demand (Bessen 2015). Vocational choices that are related to higher or lower importance of ICT-related tasks may therefore be considered as a societally relevant outcome in themselves.

Similarly to other domains like mathematics, reading, or science, individuals develop differing levels of interest and self-concept towards ICT (Sáinz and Eccles 2012; Beyer 2014; Hatlevik et al. 2018). In contrast to the popular notion of "digital natives", a pronounced heterogeneity in terms of ICT interest and self-concept also exists among adolescents born in the 1990s and later (European Commission, Directorate-General for Education, Youth, Sport and Culture 2019). Hence, we argue based on the SEVT, that

ICT interest and ICT self-concept also affect adolescents' choice of occupations in terms of the intensity and difficulty (or specificity) of ICT use associated with occupational alternatives. If adolescents enjoy using computing devices (interest, as part of the subjective task value), they should be more likely to choose an occupational pathway leading to higher levels of ICT use. Similarly, if adolescents perceive themselves as competent users of ICT (self-concept of ability as a determinant of the expectation of success) regardless of their "true" abilities, they should be more likely to choose occupations requiring a more intensive, and possibly more advanced, use of ICT. Our argument presupposes that adolescents possess a certain amount of accurate knowledge about the intensity and type of ICT use involved in different occupational alternatives.

In line with our general argument, ICT interest is cited by computer science students as a main reason for choosing this subject (Beyer 2014; Kori et al. 2015). ICT self-concept has already been found to predict aspirations for ICT-related studies (Sáinz and Eccles 2012) and higher technical abilities with regard to ICT (objectively measured) are associated with the intention to study or work in the ICT sector (Kaarakainen 2019). In the context of VET, average ICT competence levels differ systematically between different programs, suggesting that the selection is influenced by individuals' affinity to ICT (Findeisen and Wild 2022). Finally, recent research describes the specific transitioning process from early interests and ICT-related hobbies into occupational plans (the "hobby-to-career-reckoning"; Peterson et al. 2024). Otherwise, there is hardly any empirical evidence on the influence of ICT interest and ICT self-concept on occupational pathways. We are specifically unaware of any studies which conceptualize ICT use at work more broadly and consider the use of ICT both in and outside of ICT-specialist occupations.

Compared to other domains like mathematics and science, the role of the ICT domain in today's world of work is conceptually special in at least two respects. First, ICT-related tasks at work can involve tasks across a broad range of difficulty, from rather basic applications which are part of everyday life in affluent countries (e.g., office applications, email, internet use to find information) to very technical and advanced applications (e.g., programming, use of specialized software; European Commission, Directorate-General for Education, Youth, Sport and Culture 2019). Consequently, empirical studies on ICT use in the workplace and the associated skill demands often distinguish between basic and advanced levels of ICT use and skills (Falck et al. 2021; Fernández-Macías and Bisello 2022). Second, the use of both basic and advanced ICT at work permeates occupations across almost all sectors. The use of advanced ICT at work such as using specialized software or programming computer code has become part of occupations that are not typical "ICT specialists", such as jobs in accounting, (online) marketing, care, and many more. Particularly the growing importance of data in many sectors (e.g., healthcare or business) requires the skilled use of specialized software also for workers who are not ICT specialists.

Given these arguments, the association between ICT interest and self-concept on the one hand and the intensity of ICT use in the chosen occupation on the other hand may differ, depending on the specific type of ICT use required in a certain occupation. It seems likely that due to its close relationship with abilities, ICT self-concept should be more relevant for the choice of occupations involving more advanced ICT use (e.g., programming), while intrinsic motivation to use computers (interest) may be similarly

important in affecting the intensity of basic and of advanced ICT use in a future job. These considerations lead to our first hypotheses:

Hypothesis 1 Adolescents' ICT interest is positively related to the intensity of basic ICT use and advanced ICT use in their future occupations.

Hypothesis 2 Adolescents' ICT self-concept is positively related to the intensity of advanced ICT use in their future occupations.

Gendered vocational choices regarding ICT

Women continue to be strongly underrepresented in occupations in the ICT sector (e.g., software engineers) and in related postsecondary education programs (Düll 2020). According to empirical research, female underrepresentation in computer sciences is largely unrelated to ability (Beyer 2014). Instead, most studies attribute female aversion to ICT-related careers to stereotypes that are incompatible with most women's gender identities (Gottfredson 2002), to women's lower interest in working with things as opposed to people (Su et al. 2009), and to women's typically lower self-perceived abilities regarding certain aspects of ICT use (Borokhovski et al. 2018). At the same time however, women are generally more likely to use computers at work than men (Kristal et al. 2024). Hence, women are not generally more reluctant to select occupations involving ICT use than men. It is specifically those occupations that involve a high intensity of tasks related to the more technical aspects of ICT like software or system engineers, that many women appear to avoid (Combet 2024).

A major explanation for female underrepresentation in ICT is the stereotype of software engineers as male geeks that emerged with the rise of the home computer (Abbate 2012) and the related image of the ICT sector as a male-dominated sphere that lacks empathy towards women or actively discriminates against them (Cheryan et al. 2015; Wiener 2020). According to the SEVT, entering male-dominated occupations may be associated with high emotional cost (e.g., judgement from significant others and discrimination at work) that may outweigh the intrinsic value even for girls who are highly interested in ICT (Eccles et al. 1983; Cheryan et al. 2015). Other prominent theories also highlight how prevailing gender stereotypes prevent adolescents from seriously considering gender-atypical alternatives as these conflict with their gender identity (Gottfredson 2005).

While the influence of stereotypes limiting occupational alternatives is quite well-established also with regard to ICT (Beyer 2014), gendered ICT interest and self-concept may play an important role as well, particularly as there are occupational alternatives outside the ICT sector where ICT use also plays an important role. Empirical research demonstrates consistently that women's higher interest in working with people and men's higher interest in working with things are powerful explanations for occupational gender segregation (Su et al. 2009; Kuhn and Wolter 2022). Although ICT have become an important means of social communication, their core is arguably still fundamentally technical. Hence, the more technical aspects of ICT are likely to raise more intrinsic interest among young men. In sum, we can assume female adolescents to be less likely to choose occupations requiring a high intensity of advanced ICT use. However, we are unaware of previous empirical studies explicitly testing to what extent female

underrepresentation in occupations requiring more intensive advanced ICT use can be attributed to lower ICT interest.

Women's lower self-perceived abilities regarding ICT are another important explanation for their lower likelihood to select careers that involve advanced use of ICT (Beyer 2014). In contrast to other domains which are traditionally featured in schools (e.g., mathematics, science), ICT-related ability beliefs emerge largely independently of schools, e.g., through ICT use at home or in peer contexts (Juhanák et al. 2019), where boys and girls show marked differences in the ways they use ICT during leisure time. Boys tend to play more video games, while girls use ICT more for social media and communication purposes (Leonhardt and Overå 2021). Parental mediation of ICT use in childhood and adolescence also often differs by children's gender, with girls being more strictly monitored compared to boys (Steinberg et al. 2024). Because fathers are far more likely to work as ICT specialists than mothers, parents as key role models may also inadvertently reinforce gender stereotypes regarding ICT. The absence of regular ability signals by teachers regarding ICT-related abilities increases the scope for individual (mis-) perceptions of ICT-related abilities shaped by gendered socialization processes.

In line with the differentiation between basic and advanced ICT we are making, young women tend to display significantly lower self-perceived abilities mainly regarding the use of advanced ICT (referring to more technical ICT tasks) compared to young men (European Commission, Directorate-General for Education, Youth, Sport and Culture 2019). In the logic of the SEVT, girls' less positive average ICT self-concept should make them less likely to select occupations involving greater intensity of advanced ICT use.

Hypothesis 3 Girls' lower average ICT interest explains a significant share of the (expected) gender gap in advanced ICT use in their future occupations.

Hypothesis 4 Girls' less positive average ICT self-concept explains a significant share of the (expected) gender gap in advanced ICT use in their future occupations.

The moderating role of gender

The effects of domain-specific interests and self-concepts on the choice of occupations likely differ by gender to some extent. Considering many initiatives targeted explicitly at either girls or boys' choices of ICT-related careers (European Institute for Gender Equality 2018), such heterogeneous effects by gender would be of high practical relevance (Kang et al. 2021: 529). Nevertheless, we are unaware of previous empirical research exploring such effect heterogeneity by gender specifically for the ICT domain.

In general, empirical studies on vocational choice often find that women's choices are more strongly aligned with their interests (intrinsic values) than men's (Beyer 2014: 172). For example, female students in STEM subjects in higher education tend to report a greater fit between their interests and the content of their program than male students (Schelfhout et al. 2021). Science interest has also been found to be a stronger predictor of science aspirations for women than for men (Kang et al. 2021). The reasons for this pattern are not entirely clear. It may be related to the male breadwinner model and related gender stereotypes (Davis and Greenstein 2009), according to which men must more strongly prioritize material aspects when choosing careers than women (Combet 2024), possibly leaving more room for women to choose careers in line with their

interests. Based on these considerations and the state of empirical research, we would expect ICT interest to have stronger predictive effects for girls than for boys (Hypothesis 5a).

Due to the emotional costs of entering a male-dominated field, girls' ICT interest may only influence their selection of occupations outside the ICT sector, as most girls do not seriously consider ICT specialist occupations in the first place (Cheryan et al. 2015). Additionally, the number of available positions in female-typed occupations in the Swiss VET system is much lower than the number of positions in male-typed occupations (Borkowsky 2000; Hirschi 2009). This structural characteristic of the Swiss VET market may compel more girls than boys to select gender role-conformant occupations that align less closely with their individual occupational interests. Contrary to the arguments underlying Hypothesis 5a, both mechanisms would contribute to a diminished effect of ICT interest on occupational choices among girls (Hypothesis 5b).

For ICT self-concept, it is less certain whether to expect a moderation of the association by gender. Given that occupations involving high intensity of advanced ICT use are stereotyped as male, one could argue that most girls will choose ICT-intensive careers only if they have a very strong expectancy of success (indicated by a positive ICT self-concept), while boys are more likely to choose such careers not because of a positive ICT self-concept, but simply because these careers align well with their gender identity. Hence, we would expect a greater predictive strength of ICT self-concept for girls than for boys, particularly regarding advanced ICT use in future occupations (Hypothesis 6a). However, the emotional cost of a gender-atypical choice and the lower availability of positions in female-typed VET occupations that we discussed before, may also outweigh the influence of their self-concept for girls who are confident in their ICT-related skills, potentially leading to a reversed moderation effect (Hypothesis 6b).

Hypothesis 5a The positive association between ICT interest and basic and advanced ICT use intensity in future occupations is stronger for girls than for boys.

Hypothesis 5b The positive association between ICT interest and basic and advanced ICT use intensity in future occupations is stronger for boys than for girls.

Hypothesis 6a The positive association between ICT self-concept and advanced ICT use intensity in future occupations is stronger for girls than for boys.

Hypothesis 6b The positive association between ICT self-concept and advanced ICT use intensity in future occupations is stronger for boys than for girls.

Selection into occupations in the ICT sector

Although the same theoretical arguments regarding the role of ICT interest and self-concept should apply, occupational choice processes may differ regarding ICT specialist careers. We expect that the salience of both ICT interest and self-concept as predictors of vocational choices should be particularly pronounced for ICT specialist occupations, which not only involve the use of ICT as tools, but are also fundamentally oriented towards them, which affects the work environment and adolescents' perception of the fit with their own personality, including interests and self-concepts (Brown and Lent 2005). Additionally, we expect that ICT self-concept may play an even greater role than ICT

interest in the selection of such occupations compared to the whole set of possible occupations, given the perceived difficulty and technical demands typically associated with ICT specialist careers. Due to the (gender) stereotypes associated with careers in ICT, the choice processes are again likely to differ by gender. We still expect to find positive associations for both ICT interest and self-concept overall:

Hypothesis 7 Adolescents' ICT interest is positively related to the likelihood of selecting into an ICT specialist occupation.

Hypothesis 8 Adolescents' ICT self-concept is positively related to the likelihood of selecting into an ICT specialist occupation.

Methods

Data

The individual-level data stems from the second cohort of TREE (Transitions from Education to Employment), a representative panel survey following up post-compulsory school leavers from Switzerland (Hupka-Brunner et al. 2023). The baseline survey with 8,429 participating respondents was conducted in 2016, when participants were in school year nine, the final year of compulsory schooling in Switzerland. Participants were subsequently interviewed annually. At the time when the analyses for this article were conducted, data was available for the first three years after the baseline survey (data release version 2.0.0: TREE 2023).

In the baseline survey, 4,162 respondents completed the extension questionnaire covering the questions on ICT interest and self-concept (random sample split). In total, 2,207 respondents reported having entered a firm-based vocational training program within the first three years after baseline survey and therefore qualified for the analysis sample. In case of interruption or change of VET during the observation period, we considered the first firm-based VET undertaken (this applies to 115 out of 2,207 [5.2%] of cases). After performing listwise deletion of respondents with missing information in one of the variables used for the analysis, 1,995 respondents remained in the final analysis sample. All variables except those referring to the firm-based VET were measured at the baseline wave.

In each wave, the respondents reported both their current VET program and the industry branch of their current training firm. Given the alignment between vocational training and occupational outcomes in Switzerland, we used the reported VET as a proxy for the respondent's most likely future occupation. Combined with the reported industry, this proxy for occupation was used to construct occupation-industry combinations, which form the basis for merging external task indicators to the combinations provided in the TREE2 data.

The task indicators were drawn from the European database of task indices for socio-economic research (Bisello et al. 2021; Fernández-Macías and Bisello 2022). This database provides a wide range of standardized task intensity indicators (ranging from 0 to 1), which reflect the intensity of specific task contents, work methods and tool usage within specific occupation-industry combinations.[1] The original task indices were developed

[1] The occupation-industry combinations are based on occupations classified according to the International Standard Classification of Occupations (ISCO-08, two digits), and industry branches according to the European classification system named Nace.rev2.

by combining data from three sources: PIAAC (OECD Survey of Adult Skills), EWCS (European Working Conditions Survey), and ICP (Italian Indagine Camionara sulle Professioni). These sources provide detailed information on task contents and technology use across European occupations. The database's authors applied statistical techniques such as factor analysis and index construction to generate coherent and comparable task indicators (for details see Bisello et al. 2021). The indices were further weighted using employment data from the European Labour Force Survey, ensuring their relevance to the structure of the European labour market. In previous research, the indices were used to describe and compare job profiles, examine wage correlations, and evaluate the effects of technological change (Fernández-Macías et al. 2023).

In our study, we merged each respondent's occupation–industry combination with the corresponding values in the database, assigning the externally estimated scores for basic and advanced ICT use to their anticipated occupations. While the database is based on European data, we assume that the indicators are broadly applicable in the Swiss context due to structural similarities in the vocational and occupational systems (see also the Discussion section).

Measures

Dependent variables

The intensity of *basic ICT use* (first dependent variable) in each occupation-industry combination was measured using the respective indicator from the European database of task indices. The indicator is based on four individual items which were all surveyed in the PIAAC study. The four items referred to the frequency of using email, spreadsheet software, word processors, and the Internet, the latter to "better understand issues related to your work" as part of the respondents' current jobs (Bisello et al. 2021). The intensity of *advanced ICT use* (second dependent variable) was measured using the respective indicator which is based on individual items surveyed in the PIAAC study and in the ICP. These items covered the frequency of using a programming language to write computer code, respondents' knowledge of different aspects of the technical aspects of computer hardware and software, the use of computers "to program, write software, adjust functions, enter data, or process information" and the writing of computer programs "for various purposes" (Bisello et al. 2021: 38). The correlation between the intensity of basic ICT use and the intensity of advanced ICT use in our analysis sample was $r = .59$ (Pearson correlation coefficient). To investigate Hypotheses 7 and 8, we generated a binary variable distinguishing between *ICT specialist occupations* (including the following VET programs: ICT specialists, Media Technicians[2]) and all remaining occupations. Summary statistics of the dependent variables and all other measures are presented in Table 1.

Independent variables

Adolescents' ICT self-concept was measured as a scale from TREE2 based on the three items "I have always been good at working with computers", "I know more about computers than most people of my age", and "I am able to give advice when others have problems with computers" (agreement on a four-point scale). ICT interest was measured as

[2] The VET program "Building ICT specialist" was created after the data used in this study was collected.

Table 1 Descriptive statistics

	Mean (SD) or %		
	Full sample	**Girls**	**Boys**
Dependent variables:			
Intensity of ICT use in future occupation (scale 0–1)			
Basic ICT	0.55 (0.19)	0.54 (0.19)	0.57 (0.19)
Advanced ICT	0.17 (0.16)	0.13 (0.10)	0.20 (0.19)
Future occupation: ICT specialist	4.0%	1.2%	7.0%
Independent variables:			
ICT interest (z-standardized scale)	0.05 (0.91)	−0.34 (0.79)	0.38 (0.88)
ICT self-concept (z-standardized scale)	0.09 (0.92)	−0.24 (0.80)	0.36 (0.92)
Control variables:			
Verbal self-concept (z-standardized scale)	−0.07 (0.91)	0.06 (0.93)	−0.18 (0.87)
Mathematical self-concept (z-standardized scale)	−0.03 (1.00)	−0.43 (0.94)	0.30 (0.92)
Mathematics performance at school year nine (WLE)	−0.43 (1.21)	−0.59 (1.08)	−0.28 (1.29)
School mark in science (1–6)[a]	4.67 (0.66)	4.61 (0.64)	4.72 (0.69)
School mark in mathematics (1–6)[a]	4.57 (0.72)	4.40 (0.77)	4.71 (0.64)
School mark in first language (1–6)[a]	4.66 (0.50)	4.70 (0.52)	4.62 (0.48)
Parental HISEI-08 (highest socioeconomic status based on occupation)[b]	51.39 (20.35)	49.9 (19.8)	52.7 (20.7)
At least one parent is ICT specialist			
No	95.8%	96.8%	95.0%
Yes	4.2%	3.2%	5.0%
Gender			
Female	45.5%	-	-
Male	54.5%	-	-
Highest parental educational attainment			
Compulsory schooling	16.9%	18.7%	15.5%
Upper secondary education	54.4%	56.9%	52.4%
Tertiary education	28.7%	24.5%	32.1%
Language region			
German	84.8%	87.5%	82.5%
French	13.1%	11.0%	14.8%
Italian	2.2%	1.5%	2.8%
Level of secondary education (educational track)			
Basic/Low requirements	43.3%	42.2%	44.3%
Advanced requirements	50.2%	51.1%	49.4%
High requirements	6.5%	6.8%	6.2%
Number of observations	1,995	1,036	959

SD = Standard deviation. Weighted statistics

[a] GPA = grade point average. 6 = highest possible mark, 1 = lowest possible mark

[b] Sample minimum: 14.2, sample maximum: 88.7

a scale based on the three items "Using computers is fun", "I am interested in technology", and "I like learning with computers" (agreement on a four-point scale). The items on which both scales were built stem from the International Computer and Information Literacy Study (ICILS) 2013. The correlation between ICT interest and ICT self-concept in the analysis was $r = .69$, suggesting sufficient differentiation of the variables to be analyzed separately.

Control variables

We included verbal and mathematical self-concepts measured at the baseline survey as control variables, because subject-specific self-concepts have been shown to be interdependent and may therefore be correlated with ICT self-concept (Marsh and Hau 2004). Moreover, we included mathematics performance measured in a standardized test (weighted likelihood estimates [WLE]) at the end of the final (9th) school year, and self-reported school marks in science, mathematics, and in the first language.

Parents working as ICT specialists may serve as role models or be particularly effective in fostering their child's ICT interest and ICT-related careers (Adya and Kaiser 2005), which is why we controlled for this case based on a classification developed by the OECD (Grundke et al. 2017). Furthermore, demographic variables like parental socioeconomic status (highest ISEI-08 value), respondents' gender, highest parental educational attainment, and language region were included as control variables. Finally, the level of secondary education (educational track) is an important determinant of occupational pathways in Switzerland, as it is used by employers as a signal for applicants' academic performance. Similarly, it may also affect adolescents' self-concept of abilities, as the SEVT would suggest, so we included it as our final control variable.[3]

Analytical strategy

We applied multivariate beta regression models to estimate the association between ICT interest and ICT self-concept and the main outcome variables, the job task content indicators (Hypotheses 1, 2, 5a, 5b, 6a, and 6b). The beta regression model was chosen because the distribution of the dependent variables was heavily skewed and by design limited to the range between zero and one, which made beta regression the appropriate model choice (Ferrari and Cribari-Neto 2004). However, beta regression is not feasible when the dependent variable contains values exactly at the thresholds zero and one, which was the case for both ICT use indicators. These values represent extreme values resulting from the same data-generating process as the rest of the distribution. Hence, we transformed the dependent variables slightly prior to the analyses, in line with an established recommendation (Smithson and Verkuilen 2006), using the following formula:

$$y' = \frac{y\,(n-1)+0.5}{n}$$

with y indicating the dependent variable (task content indicator) and n indicating the sample size (1,995 in this case). This transformation squeezes the data slightly, so that the interval changes from [0,1] to (0,1) and beta regression can be applied.

In addition, we estimated a logistic regression estimating the likelihood of entering an ICT-specialist occupation (Hypotheses 7 and 8). We present results from both beta and logistic regression analyses as average marginal effects (AMEs). AMEs represent the average change in the predicted value of the dependent variable associated with a

[3] We also estimated models that additionally controlled for level of extraversion (as part of the Big Five), addressing the potential link between introversion and ICT skills (Gnambs 2015) and family values, which may be part of broader value orientations that affect domain-specific interests while also affecting the choice of occupations with differing levels of work-family compatibility. Including these variables did not meaningfully change the results. However, because the causal ordering is ambiguous and there is a resulting risk of overcontrol bias, we do not present these results here.

marginal (small, one-unit) change in the independent variable, with all other variables held at their observed values across the sample. For example, an AME of 0.05 for gender (coded male = 0 and female = 1) would indicate that, on average, being female is associated with a 5% point increase in the predicted value of the dependent variable. AMEs, therefore, facilitate the presentation and interpretation of interaction effects and results from nonlinear regressions, which is why we use them throughout the paper when referring to results from beta regression analyses.

For investigating Hypotheses 3 and 4, we applied a Oaxaca-Blinder decomposition model (Blinder 1973; Oaxaca 1973). This model yields the percentage of a difference in an outcome variable between two groups (e.g., mean wage of women vs. men) that can be "explained" by a group difference in one or more predictor variables (Jann 2008). Essentially, the decomposition model compares the observed mean difference in the outcome to the mean difference had the predictor variable(s) been equal between both groups. All analyses were survey weighted to correct for the disproportionate sampling design. In addition, the applied survey weight corrects for selected sources of selective panel attrition (Hupka-Brunner et al. 2023). Panel wave-specific sampling weights were assigned to each respondent based on the first panel wave in which information on the analyzed episode was provided by the respondents. Strata and clustered sampling were considered in the calculation of statistical inference (i.e., standard errors, p-values, etc.), reflecting the two-step sampling design involving school-level clustering and stratification by cantons, language regions, funding bodies, and partially by school tracks.

Results

Description of dependent variables

Table 2 presents the gender balance, and the average ICT use intensity across the 30 most popular VET programs in the dataset. Most programs are highly dominated by one gender, including ICT specialists and media technicians, which display by far the highest mean values for advanced ICT use intensity. However, some programs requiring relatively high levels of basic ICT use, e.g., commercial employees, are female-dominated. The distributions of the resulting dependent variables (basic and advanced ICT use intensity in future occupations), which are displayed in Fig. 1, look very different for basic and advanced ICT use.[4] The left panel in Fig. 1 illustrates that most occupations require some amount of basic ICT use. The large spike among girls around 0.4 in the left panel can mainly be attributed to occupations in the care sector (e.g., nursing professionals, medical and dental assistants) which typically require a moderate intensity of basic ICT use (see Figure S.1, Supplementary Material) and are also strongly female-dominated. The second largest spike for both boys and girls (around 0.8) is related to commercial employees (general and keyboard clerks). Overall, mean values for basic ICT use (as displayed in Table 1) are not significantly different for boys and girls (p =.08). However, the median is higher for boys (0.52) compared to girls (0.45).

For advanced ICT use (right panel, Fig. 1), the distribution is highly skewed, much more than for basic ICT use. Most adolescents in the sample selected occupations requiring only limited use of advanced use of ICT. The spike between 0.1 and 0.2 for girls is mainly related to occupations in the care sector (e.g., health care specialists),

[4] See Figure S.1 in the Supplementary Material for distributions of the dependent variables across ISCO-08 occupations.

Table 2 Mean values of ICT use intensity across most popular VET programs

	n	% of all observations	% male	Basic ICT	Advanced ICT
Commercial employee	374	18.7	37.9	0.79	0.23
Health care specialist	148	7.4	22.9	0.44	0.12
Retail specialist	122	6.1	34.8	0.42	0.05
Childcare specialist	69	3.5	15.8	0.41	0.04
Draftsperson	65	3.3	71.9	0.87	0.26
Cook	60	3.0	66.4	0.48	0.06
ICT specialist	59	3.0	93.9	0.86	0.80
Electrical installer	57	2.9	100.0	0.53	0.27
Medical assistant	52	2.6	0.0	0.45	0.14
Polymechanic	51	2.6	91.0	0.42	0.17
Carpenter (Timber construction)	44	2.2	100.0	0.55	0.05
Joiner/Cabinetmaker	40	2.0	91.1	0.37	0.09
Logistics specialist	37	1.9	93.2	0.69	0.21
Automotive specialist	37	1.9	99.3	0.40	0.15
Hairdresser	35	1.8	1.8	0.40	0.05
Dental assistant	33	1.7	0.4	0.46	0.14
Pharmacy assistant	32	1.6	0.0	0.49	0.16
Design engineer	30	1.5	90.3	0.72	0.29
Laboratory technician	28	1.4	68.2	0.73	0.27
Farmer	28	1.4	93.8	0.48	0.08
Baker/Confectioner/Pastry chef	25	1.3	60.6	0.34	0.08
Gardener	25	1.3	35.3	0.45	0.07
Media technician	20	1.0	100.0	0.89	0.81
Metalworker	20	1.0	98.5	0.30	0.21
Automation technician	20	1.0	76.0	0.68	0.46
Automotive mechatronics technician	19	1.0	53.2	0.39	0.15
Retail assistant	19	1.0	98.7	0.40	0.05
Druggist	16	0.8	0.0	0.40	0.05
Mason	16	0.8	100.0	0.57	0.05
Restaurant specialist	15	0.8	8.5	0.46	0.07

Table presents the 30 most popular VET programs in the dataset. These account for a total of 80.0% of all individuals in the dataset. Note that the indicators of ICT use intensity are assigned to individuals in the dataset based on occupation (ISCO-08) derived from the VET program and industry of the VET firm. Hence, ICT use intensity can vary within VET programs due to different industries of the training firms. We present the distribution of indicators across all ISCO-08 occupations in the Supplementary Material (see Figures S.1 and S.2)

which can require a limited amount of sector-specific software use. The spike above 0.2 for boys and girls is mainly due to the group of commercial employees, which typically requires some advanced ICT use, e.g., the use of business or banking software. Two VET programs are mainly responsible for values exceeding 0.6 on the advanced ICT use scale: ICT specialists and media technicians. Both are strongly male-dominated in our sample (see Table 2), which is also mirrored in Fig. 1. Consequently, we find a significant gender difference regarding the average intensity of advanced ICT use, with boys selecting into occupations requiring more intensive use ($p < .001$).

ICT interest and ICT self-concept as predictors of ICT use in adolescents' future occupations (Hypotheses 1 and 2)

The analysis of ICT interest and ICT self-concept as predictors of ICT use in future occupations of adolescents on the vocational track reveals several key findings. The results displayed in Fig. 2 show that in the specification without control variables, there is a statistically significant ($p < .05$), positive association of ICT interest with the intensity of both basic and advanced ICT use in adolescents' future occupation (upper coefficient

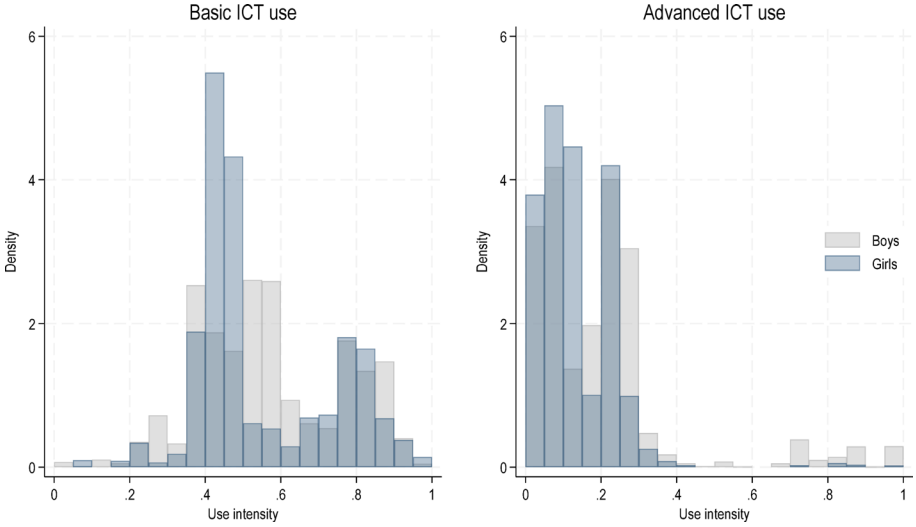

Fig. 1 Histograms of the dependent variables by gender ($n = 1{,}995$)

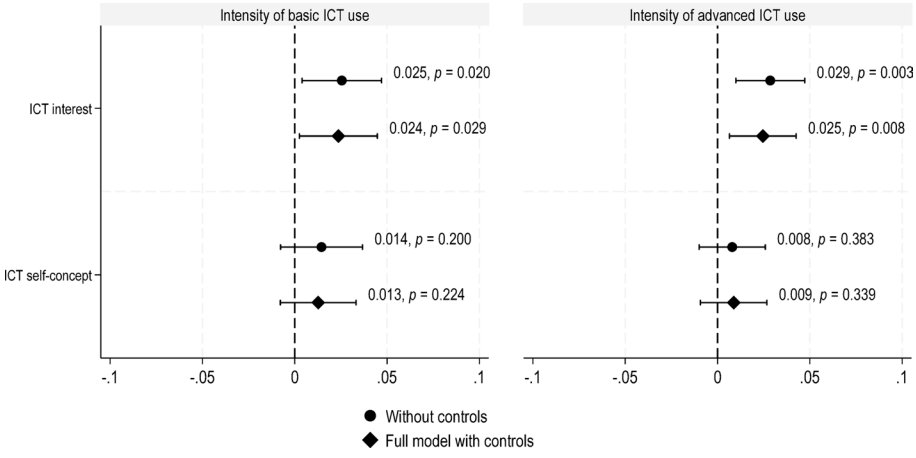

Fig. 2 Average marginal effects (AMEs) of ICT interest and ICT self-concept on the intensity of basic and advanced ICT use. Notes: $N = 1{,}995$. AMEs with 95%-confidence intervals obtained from beta regression models. Full model includes all control variables listed in Table 1. Full model coefficients are presented in Table S.1 (Supplementary Material). Interpretation: A marginal (small) increase in ICT interest or ICT self-concept is associated with an estimated increase in the dependent variable (basic or advanced ICT use intensity with range 0–1) by X scale points. A marginal increase corresponds approximately to a one unit change in both presented predictors. Figures S.3 and S.4 (Supplementary Material) additionally present adjusted predictions of the dependent variables across the distribution of ICT interest

in both panels). Adding the full set of control variables, including self-concepts regarding mathematics and reading, attenuates the coefficients for ICT interest only slightly, and they remain significant on conventional levels ($p < .05$). Hence, Hypothesis 1 is supported. Considering that the dependent variables regarding intensity of ICT use range from 0 to 1, the magnitude of the associations is relatively small (see Figures S.3 and S.4 in the Supplementary Material). For instance, the average predicted value in the intensity of basic ICT use for an adolescent with an ICT interest value of 1 is 0.047 scale points higher compared to an adolescent with an ICT interest value of − 1. For intensity of advanced ICT use, the same difference is 0.049 scale points (see Fig. 2).

In contrast, while all coefficients of ICT self-concept are positive as well, none of them are statistically significant, neither for basic nor for advanced ICT use (see right panel in

Fig. 2). Hence, there is no significant association between adolescents' ICT self-concept at the end of compulsory schooling and the intensity of basic or advanced ICT use in adolescents' future occupations. We therefore reject Hypothesis 2.

ICT interest and ICT self-concept as mediators of gendered vocational choices (Hypotheses 3 and 4)

If girls exhibit lower ICT interest and a less positive ICT self-concept compared to boys, these factors could help explain the gender disparity in the extent of advanced ICT use in future occupations (see Table 1; Fig. 1, respectively). As expected, the girls in our sample show, on average, both lower ICT interest and a less positive ICT self-concept than boys. Specifically, the mean ICT interest score for girls is −0.34, compared to 0.38 for boys (see Table 1). For ICT self-concept, the mean is −0.24 for girls and 0.36 for boys. The gender differences in these mean values are statistically significant for both ICT interest and ICT self-concept ($p < .001$).

Table 3 presents the results from twofold Oaxaca-Blinder decomposition models, which directly address Hypotheses 3 and 4. According to the pooled model, gender differences in ICT interest and self-concept jointly explain 40.4% of the total gender gap in the intensity of advanced ICT use in the chosen occupation (equivalent to 0.026 scale points). The individual contribution of ICT interest is slightly higher (25.3%) than that of ICT self-concept (15.2%). Both individual contributions are significantly greater than zero ($p < .05$), so we find general support for Hypotheses 3 and 4. However, the confidence intervals indicate that these estimates are relatively imprecise, primarily due to the limited size of the total gender gap. Nevertheless, we can conclude that the combined statistical contribution of these two factors is substantial: the lower bound of the 95%-confidence interval (0.014 scale points) still corresponds to a 23.2% contribution.

The pooled decomposition model is useful for gauging the overall extent to which ICT interest and self-concept contribute to the gender gap in advanced ICT use. However, it reflects a counterfactual scenario in which girls' and boys' ICT interest and self-concept levels are equalized through averaging. From a practical perspective, it may be more relevant to consider how the gender gap would change if girls' levels of ICT interest and self-concept were increased to match those of boys, without altering boys' levels. To

Table 3 Contributions of ICT interest and self-concept to the gender gap in the intensity of advanced ICT use

Reference group	Pooled model	Girls	Boys
Total gap (Boys – Girls)	0.064***	0.064***	0.064***
	(0.043, 0.086)	(0.043, 0.086)	(0.043, 0.086)
Explained gap [a]	0.026***	0.018**	0.029***
	(0.014, 0.038)	(0.009, 0.027)	(0.012, 0.047)
Explained components:			
ICT interest	0.016**	0.020**	0.006
	(0.005, 0.027)	(0.009, 0.031)	(−0.011, 0.022)
ICT self-concept	0.010*	−0.002	0.024**
	(0.001, 0.019)	(−0.009, 0.006)	(0.009, 0.039)

N = 1,995. Results from twofold linear Oaxaca-Blinder decomposition models with control variables (full control variable set, as presented in Table 1). 95%-confidence intervals in parentheses. Detailed model results presented in Table S.2 (Supplementary Material)

*$p < .05$, **$p < .01$, ***$p < .001$

[a] Endowment (excluding control variables)

explore this, we present additional decomposition results using either girls or boys as the reference group.

Table 3 reveals pronounced asymmetries depending on the chosen reference group. If girls' ICT interest and ICT self-concept were equal to the levels observed for boys, the gender gap would be reduced by 28.0% (equivalent to 0.018 scale points). When looking at the individual components, we find that only ICT interest contributes to the total gender gap. This implies that, mathematically, equalizing girls' ICT self-concept to that of boys would not affect the gender gap in advanced ICT use, whereas increasing their ICT interest would lead to a partial reduction. Conversely, using boys as the reference group (right column in Table 3) – although this may be less socially desirable – suggests that adjusting boys' ICT interest and self-concept down to the levels observed for girls would reduce the gender gap by 45.7% (0.029 scale points). Interestingly, ICT self-concept makes a strong contribution in this case, despite not contributing to the gap when girls are the reference group (middle column). We discuss this asymmetry further in the following section.

Gender as a moderator of ICT interest and ICT self-concept (Hypotheses 5a, 5b, 6a, and 6b)

Figure 3 displays the associations of ICT interest and ICT self-concept with both outcome variables (intensity of basic and advanced ICT use in the future occupation), separately by gender. Except for the moderation term, the results in Fig. 3 were obtained using the same model specification used to generate Fig. 2. Overall, the patterns for basic and advanced ICT use look quite similar. We find that higher ICT interest significantly predicts higher intensity of both basic and advanced ICT use only for girls, not for boys. For ICT self-concept, the pattern is reversed. For boys, but not for girls, a more positive ICT self-concept is related to a significantly higher use of both basic and advanced ICT in future occupations. The gender differences in the estimates are statistically significant for all predictors ($p < .05$). We therefore accept Hypotheses 5a and 6b and reject Hypotheses 5b and 6a. These findings help explain the asymmetrical results of the decomposition analysis in Table 3. For example, because their ICT self-concept is unrelated to girls'

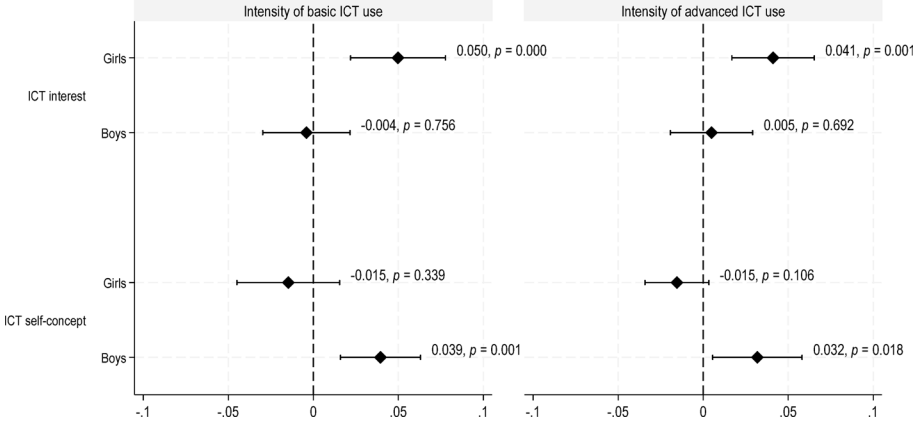

Fig. 3 Gender-specific AMEs of ICT interest and ICT self-concept for both outcome variables. Notes: $N = 1{,}995$. Group-specific AMEs obtained from beta regression models, including two terms interacting gender with ICT interest and ICT self-concept, respectively. Models included all control variables listed in Table 1. Full model coefficients presented in Table S.3 (Supplementary Material). Interpretation: A marginal increase in ICT interest or ICT self-concept is associated with an estimated increase in the dependent variable (task content indicator with range 0–1) by X scale points for girls (boys). A marginal increase corresponds approximately to a change of one unit in the two predictors presented

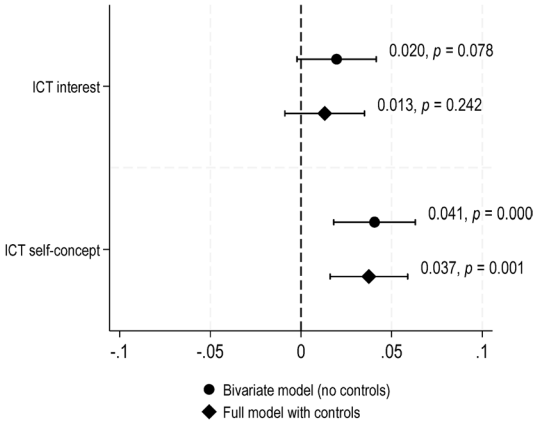

Fig. 4 AMEs on the probability to select into an ICT specialist occupation. Notes: $N = 1{,}995$. AMEs obtained from a logistic regression model. Full model coefficients presented in Table S.4 (Supplementary Material). Interpretation: A marginal increase in ICT interest or ICT self-concept is associated with an increase in the probability of entering an ICT specialist occupation use by X percentage points

selection into occupations (firm-based VET programs) in terms of advanced ICT use intensity, adjusting girls' self-concept does not affect the size of the gender gap. However, because boys' ICT self-concept is strongly related to the outcome variables, we find that adjusting their ICT self-concept indeed affects the gender gap. The opposite holds for ICT interest.

In-depth analyses of ICT specialists (Hypotheses 7 and 8)

Our analysis based on logistic regression models (AMEs presented in Fig. 4) shows that higher ICT interest is not significantly associated with a higher probability of entering an ICT specialist occupation. This finding stands in contrast to the earlier results shown in Fig. 2, where ICT interest was significantly and positively associated with the overall intensity of advanced ICT use. We must therefore reject Hypothesis 7. Again in contrast to the findings from the linear model (Fig. 2), we find that ICT self-concept is significantly and positively associated with the probability of selecting into an ICT-specialist occupation, supporting Hypothesis 8. The AME from the full model indicates that a marginal increase in ICT self-concept (approximately equivalent to one standard deviation) is associated with a 3.7% point increase in the probability of selecting into an ICT specialist career. Unfortunately, we are unable to estimate gender-specific effects from this logistic regression model due to the very small number of girls in our sample who selected an ICT-specialist occupation ($n = 12$). As a result, any gender-specific coefficient for girls would be statistically unreliable.

Discussion

Using a novel database of ICT use intensity across occupations and individual-level data on school-to-VET transitions in Switzerland, our study examined the general role of ICT interest and ICT self-concept for vocational choice processes in adolescence and their implications for occupational gender segregation. We find that Swiss adolescents' ICT interest at the end of compulsory schooling significantly predicts the intensity of both basic and advanced ICT use in their future occupation, as reflected by their chosen VET program and the industry branch of their training firm. Our findings indicate that the role of ICT interest and self-concept in vocational choice processes regarding ICT

specialist occupations (Hypotheses 7 and 8) differs from the general choice of occupations with differing levels of ICT use (Hypotheses 1 and 2). ICT interest in adolescence appears to influence only the extent to which ICT are used in future occupations but it is unrelated to the choice of ICT specialist occupations, while ICT self-concept only predicts the latter.

This result is surprising given our theoretical arguments derived from the SEVT, according to which both intrinsic motivation and ability-related beliefs are relevant for occupational choices (Eccles et al. 1983). Adolescents (particularly female adolescents), when choosing occupations in the context of VET, appear to consider their interest in working with ICT on a daily basis in their future careers (referring to ICT use mainly as tools of work, and not as the content of a job). The similarity of the observed empirical patterns regarding basic and advanced ICT use suggests that adolescents consider mainly the anticipated extent of ICT use in future occupations or features of the work environment in ICT-intensive occupations, rather than the specific type of difficulty of activity (e.g., using email or word processing programs vs. programming and specific software use). Other aspects of ICT use, like its strong connection to desk work, may partly drive the observed associations. This use of ICT as tools is likely only a secondary decision criterion among many others for adolescents, which is also apparent in the relatively small associations we find. When deciding whether to pursue a career as an ICT specialist, however, Swiss adolescents appear to mainly consider whether they think they are able to succeed in this area and largely disregard the intrinsic value of working in this field.

Implications for occupational gender segregation regarding ICT

Our study also provides interesting insights into the relationship between gender and ICT in the labor market. Although women tend to be even slightly more likely to use ICT at work than men (Kristal et al. 2024), they remain particularly underrepresented in ICT-specialist occupations like software engineers (Beyer 2014), which is problematic because ICT specialist jobs offer favorable conditions regarding work-life balance, facilitate childcare arrangements, and pay high wages, thus increasing the share of women working in this sector could help diminish the gender pay gap (European Institute for Gender Equality 2018). Moreover, ongoing shortages of (female) ICT specialists can hamper economic development on a national scale (Düll 2020). Countless studies have attributed female underrepresentation in the ICT sector to the influence of stereotypes such as "computer nerds" being incompatible with female gender identity and potentially associated fears of a work environment marked by a lack of empathy and communication, or even, misogyny and discrimination (Cheryan et al. 2015; Kriesi and Imdorf 2019; Wiener 2020).

Our findings indicate that girls' lower average interest in ICT (Hypothesis 3) and their less positive ICT self-concept (Hypothesis 4) contribute significantly to selection into occupations that involve less intensive use of advanced ICT. If Swiss girls were similarly interested in ICT as Swiss boys, this would partially mitigate the gender gap in terms of advanced ICT use at work – with potential positive ramifications for labor market outcomes such as wages. We are also able to show that ICT interest is a significantly stronger predictor of ICT use intensity in future occupations for girls than for boys (supporting Hypothesis 5a as opposed to Hypothesis 5b), although girls are structurally

disadvantaged in terms of the availability of gender-conformant positions in the Swiss VET system (Hirschi 2009), which likely forces many of them to make compromises in terms of their occupations interests. This suggests that some girls may consciously embrace advanced ICT use as a part of their future careers. In line with previous studies on other fields (Beyer 2014; Kang et al. 2021), our results highlight the particular importance of intrinsic criteria in general (Beyer 2014) and ICT interest in particular, in shaping girls' vocational choices.

In contrast, we find that ICT self-concept is not a significant predictor of girls' selection into more ICT-intensive careers, but there is a significant and positive association for boys (supporting Hypothesis 6b as opposed to Hypothesis 6a). Here, the theoretical implication is that most girls likely do not seriously consider VET occupations that require an intensive amount of ICT use (like ICT specialists) due to emotional cost of gender-atypical choices or conflicts with their gender identity (Gottfredson 2005). Hence, confidence in their own ICT-related skills (ICT self-concept) becomes largely irrelevant, as the remaining occupational alternatives involve only limited amounts of advanced ICT use. For boys, this result suggests that expectations of success play a much more important role than the intrinsic value of working in ICT-intensive occupations.

Considering the steady growth of ICT use in occupations across sectors (Fernández-Macías et al. 2023) and the demonstrated importance of ICT interest for girls choosing VET occupations, girls' lower average interest in ICT may exacerbate the shortages of suitable positions that girls face on the Swiss VET market. For practical implications, this means that fostering girls' interest in ICT may be an effective measure to improve the fit between girls' preferences and available apprenticeship positions, although our results also indicate that this would likely not increase female representation in ICT-specialist occupations. If anything, our results suggest that fostering girls' ICT self-concept may be a pathway to achieve the latter, as ICT self-concept is associated with a higher probability to enter an ICT-specialist occupation. However, as the latter association is almost entirely driven by the boys in our sample (as very few girls in our sample entered ICT specialist occupations), we cannot be sure and must leave this question for future studies to investigate in more detail.

Raising the share of female ICT specialists continues to be a challenging endeavor. Our findings suggest that potentially, changing task profiles of occupations or re-labeling them may be a way to attract women into the ICT sector. Stereotypes may be much less salient when occupations are not entirely focused on writing code, but instead by default include a more diverse array of tasks and methods used at work. We therefore agree with the general argument behind Combet's (2024: 252) suggestion to explicitly advertise the diversity of tasks or methods required as part of study programs or occupations in order to attract more women into STEM (or ICT, in this specific case).

Finally, the fact that interest in ICT was relevant only for girls, but not for boys, raises the question whether the absence of a link for boys is problematic for the latter. Considering the beneficial effects of a good fit between vocational interests and work environments (Wilkins and Tracey 2014), we wonder what prevented the realization of a higher ICT use intensity at work for the boys in our sample who were highly interested in ICT. Possibly, boys' lower average school marks which are considered by training firms in the Swiss context, restrict the freedom of choice for some of them. The adverse individual

outcomes of a poor fit between occupational interests and environments would merit further research investigating this point.

Limitations and future research

Overall, we see our study as an explorative starting point for a potentially fruitful discussion of the psychosocial processes of vocational choices regarding the ICT domain. In the following, we acknowledge and discuss the study's main limitations, highlighting several unanswered questions that could guide future research.

First, while our main research question concerns the influence of interests and self-concepts on career choices, our research design can provide only associational evidence. The association between ICT interest and ICT use in future occupations may partly reflect adolescents' choice of training programs as suggested by our theoretical reference to the SEVT as well as employers' preferences for interested and motivated candidates, particularly in early-career positions (Duc and Lamamra 2022). We are essentially unable to disentangle the contribution of adolescents and the training firms to the reported associations empirically. Hence, the results represent an important first step, identifying an association that future studies may try to understand in more detail. Second, using school-leavers' VET programs and training firm industries as proxies for future occupations captures career pathways in the Swiss labor market with good accuracy (the long-term probability of staying in the initial training occupation exceeds 50%; Bundesamt für Statistik 2020). Still, accuracy could be further improved by using data on actual occupations over time, which was not available to us.

Third, our measures could be refined. It is generally complex to empirically measure expectancies, values and many of the constructs in the SEVT, with measures often being one-sided or simplified (Eccles and Wigfield 2024). Future studies could benefit from differentiating more finely between basic and advanced, or technical and user-focused dimensions of ICT interest and self-concept, which may help address potential gender differences with more nuance (European Commission, Directorate-General for Education, Youth, Sport and Culture 2019).

Fourth, the outcome variables are based on European averages rather than Swiss-specific data (Bisello et al. 2021) and some differences in the structure of the labour market might exist. However, when comparing the scale across countries, *"most of the discrepancy in task scores tends to concentrate in the indicators of task methods, whereas content and tools are generally more consistent across countries"* (Fernández-Macías et al. 2016: 67). In addition, the scale construction relies on countries like Germany, Austria and Denmark, which also put high emphasis on dual VET. Fifth, our results are mainly relevant to vocational choice in the context of VET. The role of ICT in vocational choice processes involving tertiary education (e.g., regarding computer science: Beyer 2014) may differ because tertiary education programs are less closely connected to specific occupations.

Finally, with the introduction of applications relying on forms of artificial intelligence (AI), the nature of ICT use in professional contexts is currently changing. First studies have shown that the benefits of working with AI depend on prior levels of ability, but also on ability beliefs (Caplin et al. 2024). The role of ability beliefs in determining ICT-related career choices may therefore change in the future, as AI assistants promise to help solve complex tasks. Although we could not address the role of AI in this paper

as our data was collected between 2016 and 2019, this represents an interesting starting point for future studies.

Conclusions

While the demand for ICT skills has been extensively studied, there is a notable gap in understanding how the growing importance of ICT use at work (Fernández-Macías et al. 2023) affects vocational choice processes. Given the unresolved shortage of ICT specialists and the underrepresentation of women in this field, this is a highly relevant gap for research and practice (Beyer 2014; Gorbacheva et al. 2019). Our study is among the first to investigate the psychosocial determinants of ICT-related vocational choices in the context of VET. Our findings underscore how heterogeneity in adolescents' ICT interest and self-concept is related to subsequent occupational pathways and how it potentially contributes to gendered vocational trajectories. By recognizing the differentiated impacts of these factors on boys and girls that our study revealed, educators and policymakers can develop targeted interventions to support diverse pathways into ICT-related occupations. Future research should continue to explore these gender-specific dynamics and identify additional factors that can help bridge the gender gap and the general shortage of workers in professions involving high extents of advanced ICT use.

Supplementary Information

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Supplementary Material 1.

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Author contributions
All authors contributed to the conceptualization of the study and to writing the original draft and helped review and edit the manuscript. LR and DK were responsible for generating theory. LR and AG prepared the data. LR performed the statistical analyses, visualized the results and was a major contributor in writing the original draft. JH managed the project administration and acquired funding. All authors read and approved the final manuscript.

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Data availability
The survey data that support the findings of this study (TREE2) are available at: https://doi.org/10.48573/69q6-b447. Access to TREE2 data is granted for academic research and teaching purposes upon reasonable request. The European database of task indices for socio-economic research is publicly available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC124124.

Declarations

Human ethics and consent to participate
Participant consent was obtained as part of the original data collection by TREE. Ethical approval of the presented secondary data analysis was not required because no health-related or other sensible information was involved.

Competing interests
The authors declare no competing interests.

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