Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Statistics

Bachelor Thesis

Statistical Analysis of ICT Familiarity Among Students Using PISA Data: A Focus on the United Kingdom

Cecilia Mumba Chola

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Cecilia Mumba Chola

Economics and Management

Thesis title

Statistical Analysis of ICT Familiarity Among Students Using PISA Data: A Focus on the United Kingdom

---

Objectives of thesis

To statistically analyse the level of ICT-familiarity and its relationship with academic performance among UK students using PISA data

Main Research Questions

-What is the level of ICT familiarity among UK students based on PISA questionnaire items？
-How does ICT use relate to student academic performance in mathematics, and
-Are there significant differences in ICT familiarity based on gender, social economic status, or school type

- Which ICT related factors (digital confidence, ICT autonomy, attitudes toward technology) predict better academic outcomes?

Methodology

The study will be composed of a theoretical and a practical application. The theoretical part will review existing literature on ICT familiarity among students and its influence on academic performance, with an attention to demographic and socioeconomic factors. This literature will provide the background and context for the study.The practical part, will be based on the quantitative research approach, using secondary data from Programme for international student assessment (PISA) with the focus on the United Kingdom. Descriptive statistics will be used to assess ICT familiarity levels, and Inferential statistics will be applied to examine differences in

ICT familiarity across demographic groups, also to assess the relationships between ICT familiarity and academic performance.

The proposed extent of the thesis

40-60 pages without annexes

Keywords

statistical analysis; ICT familiarity; United Kingdom

Recommended information sources

GEBHARDT, Eveline T. Gender Differences in Computer and Information Literacy: An In-Depth Analysis of Data from ICILS. 2019. ISBN 978-3-032-62020-

MA, Josef Kuo-Hsun a Simon CHENG. Adolescent Well-Being and ICT Use: Social and Policy Implications. 2022. ISBN 978-3-031-04411-3. ISBN 978-3-031-04412-0.

OECD. Learning to Bridge the Digital Divide. Centre for Educational Research and Innovation. OECD Publishing, 2000. ISBN 978-1-5095-3445-6.

OECD. Students Online: Digital Technologies and Performance (Volume VI). OECD Publishing, 2011. ISBN 978-92-64-11291-9. ISBN 978-92-64-11299-5.

SKYRABIN, O. et al. Assessment of student ICT competence according to mathematics, science, and reading literacy: Evidence from PISA 2018. Large-scale Assessments in Education. 2024, 12(1).

SKYRABIN, O. et al. The influence of ICT uses and related attitudes on students' math and science performance: A multilevel analysis of PISA data. Large-scale Assessments in Education. 2022, 10(1).

THRANE, Christer. Statistical Analysis: The Basics. Taylor & Francis Group, 2024. ISBN 978-1-032-64077-8. ISBN 978-1-040-26737-0.

Expected date of thesis defence

2025/26 SS – FEM

Thesis supervisor

prof. Ing. Jindřich Špička, Ph.D.

Supervising department

Department of Statistics

Electronic approval: 24. 07. 2025

doc. Ing. Tomáš Hlavsa, Ph.D.

Head of department

Electronic approval: 22. 08. 2025

prof. Ing. Lukáš Čechura, Ph.D.

Dean

Prague on 20. 02. 2026

Declaration

I declare that I have worked on my bachelor thesis titled “Statistical analysis of ICT familiarity among students using PISA data; a focus on the United Kingdom” by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 13.03.2026 ____________________________

Acknowledgement

I would like to thank my bachelor thesis supervisor prof. Ing. Jindřich Špička, Ph.D., for his constructive, timely feedback and guidance in writing my thesis. I would also like to appreciate my family and friends for the continued support throughout my studies.

Statistical Analysis of ICT Familiarity Among Students Using PISA Data: A Focus on the United Kingdom

Abstract

The objective of this thesis is to examine the levels of ICT familiarity among students in the UK and its relationship with academic performance in mathematics and science, using the PISA 2018 dataset. The study also investigates differences in ICT use and perceived competence across gender, school type, and socioeconomic and cultural status groups.

ICT familiarity is introduced as a multifaceted construct, drawing on theories of digital divide, the technology acceptance model (TAM), and self-determination theory (SDT). These theoretical perspectives provide a framework for assessing engagement and disparities in ICT familiarity among students.

The study employs a quantitative methodology, utilising both descriptive and inferential statistics. The findings indicate that students in the United Kingdom have early access and exposure to ICT, with widespread availability of ICT resources at home and at school. However, students' use of ICT in the classroom for subject-related activities is below the OECD average.

The results further reveal a second level of digital divide in ICT use and competence across gender, school type and socio-economic groups. Furthermore, perceived ICT autonomy and the use of ICT outside lessons for subject-related purposes are positively associated with achievement in both mathematics and science. In contrast, ICT interest is negatively associated with academic achievement. ICT use in class during lessons for subject-related use and ICT competence has no significant relationship with mathematics and science.

The findings highlight that although certain ICT constructs are positively associated with academic achievement, the overall association is relatively weak.

Keywords: ICT familiarity, ICT use, ICT autonomy, ICT interest, academic achievement, UK students, PISA, mathematics, science

Statistická analýza znalostí IKT mezi studenty s využitím dat PISA: Zaměření na Spojené království

Abstrakt

Cílem této práce je prozkoumat úroveň obeznámenosti s ICT (informačními a komunikačními technologiemi) mezi studenty ve Spojeném království a její vztah k akademickým výsledkům v matematice a přírodních vědách s využitím datové sady PISA 2018. Studie rovněž zkoumá rozdíly ve využívání ICT a vnímané kompetenci v závislosti na pohlaví, typu školy a skupinách podle socioekonomického a kulturního statusu.

Obeznámenost s ICT je představena jako mnohostranný konstrukt, který vychází z teorií digitální propasti (digital divide), modelu přijetí technologie (TAM) a teorie sebeurčení (SDT). Tyto teoretické perspektivy poskytují rámec pro hodnocení zapojení a rozdílů v obeznámenosti s ICT mezi studenty.

Studie využívá kvantitativní metodologii s použitím jak deskriptivní, tak inferenční statistiky. Zjištění naznačují, že studenti ve Spojeném království mají brzký přístup k ICT a jsou s ním v kontaktu, přičemž zdroje ICT jsou široce dostupné jak doma, tak ve škole. Nicméně využívání ICT studenty ve třídě pro činnosti související s výukovými předměty je pod průměrem OECD.

Výsledky dále odhalují druhou úroveň digitální propasti ve využívání ICT a kompetencích napříč pohlavími, typy škol a socioekonomickými skupinami. Kromě toho vnímaná autonomie v oblasti ICT a využívání ICT mimo vyučování pro účely související s předmětem pozitivně korelují s dosahovanými výsledky v matematice i přírodních vědách. Naproti tomu zájem o ICT má s akademickými výsledky negativní souvislost. Využívání ICT ve třídě během vyučování pro účely daného předmětu a kompetence v ICT nemají žádný významný vztah k výsledkům v matematice a přírodních vědách.

Tato zjištění zdůrazňují, že ačkoli určité konstrukty ICT pozitivně korelují s akademickými výsledky, celková souvislost je poměrně slabá.

Klíčová slova: obeznámenost s ICT, využívání ICT, autonomie v ICT, zájem o ICT, akademické výsledky, studenti ve Spojeném království, PISA, matematika, přírodní vědy.

Table of Contents

1. Introduction

In modern education, students' familiarity with Information Communication Technology (ICT) has become essential in shaping their educational experiences and outcomes. ICT skills serve not only as instructional tools but also influence students' engagement with technology and the development of competencies crucial for participation in the digital age.

The increasing integration of digital technology into educational curricula reflects broader economic and societal transformations driven by technological advancements. This integration has fundamentally transformed teaching and learning processes. As a result, students' proficiency and familiarity with ICT are vital for assessing the association between ICT and academic performance.

The evolution of Information and Communication Technology (ICT) in educational settings has progressed from fundamental computer lessons to more sophisticated aspects such as digital competence, digital communication, information management, and computational thinking. This development has influenced both application and skill development in the sector, fostering a more complex learning environment that requires diverse ICT dynamics for effective use and the cultivation of competencies. Furthermore, the integration has greatly improved educational processes by providing access to a wide range of resources, software, and digital tools. As digital technology continues to influence educational systems, ICT has become essential for student success, and the ability to use ICT tools effectively significantly boosts students' ICT learning outcomes, confidence, and future job prospects.

The United Kingdom offers an interesting perspective due to its developed economy and advanced technology. Therefore, understanding students' utilisation of ICT resources and how varying usage patterns are associated with academic performance is important for implementing effective ICT use policies. This study seeks to examine the relationship between ICT use (including both physical engagement and psychological perception) and academic achievement.

2. Objectives and Methodology

The section explains the research questions and the methodological approach used.

The main objective of this study is to analyse the levels of ICT familiarity and its relationship with academic performance among students in the UK. Addressing this matter is essential to answering the subsequent research questions.

2.1. Research Questions

I. What is the level of ICT familiarity among students in the UK as measured by PISA questionnaire items capturing various dimensions such as access, exposure, and attitudes?

II. How does ICT use relate to student academic performance in mathematics and science?

III. How does ICT familiarity differ based on gender, socioeconomic status, or school type?

IV. Which ICT-related variables, such as digital confidence, ICT autonomy, and attitudes, predict better academic outcomes?

2.2. Methodology

This study adopts a quantitative research methodology. This approach is suitable as the study aims to assess and analyse ICT familiarity utilising secondary data collected by the Organisation for Economic Co-operation and Development (OECD). It facilitates the examination of relationships between ICT variables, academic performance, and various demographic and socioeconomic factors.

2.3. Data source

The data source for this study comprises secondary data obtained from the Programme for International Student Assessment (PISA) 2018 dataset, collected by OECD. Access to the complete dataset, which includes student and school questionnaire responses along with the corresponding codebooks, is provided through publicly available use files (PUFs) accessible on the OECD website (OECD, 2018).

The PISA 2018 data cycle is utilised in this study for its comprehensive coverage of ICT-related variables. This cycle provides valuable insights into students' psychological perceptions related to ICT, thereby offering an understanding of how students perceive themselves in relation to ICT.

2.4. Target Population

The study focuses on PISA's target population from the 2018 cycle. The PISA target demographic comprises 15-year-old students enrolled in public and private schools who are in grade 7 or higher at the beginning of the testing period. The study treats the United Kingdom as the main unit of analysis, representing the national results of England, Wales, Northern Ireland, and Scotland.

The United Kingdom attained a weighted school response rate of 72.9% among the principal sample of schools, below the OECD benchmark. However, in accordance with OECD guidelines, replacement schools were systematically included, resulting in an increased response rate of 86.6%. This exceeded the stipulated threshold and confirmed compliance with OECD participation standards (Sizmur et al., 2019).

Meeting the OECD's response rate criteria indicates that the United Kingdom's PISA 2018 sample remains statistically representative at the national level. Consequently, the dataset is regarded as methodologically sound and appropriate for secondary analyses concerning both student-level and school-level variables.

2.5. Software Analysis

The data analysis adheres to the procedures recommended by OECD for PISA data processing. All analyses are conducted using IBM SPSS Statistics, employing syntax generated by the IEA IDB analyser to accurately estimate standard errors and plausible values estimates. (OECD, 2026)(OECD, 2009).

2.6. Plausible values handling

When handling the academic achievement variables, reported as plausible values, the regression models must be estimated independently for each of the 10 plausible values in mathematics and science. The results are then averaged to calculate the final estimates and properly account for measurement uncertainty in the students(OECD, 2020). In this study, the plausible values were automatically handled using the IEA IDB analyser.

2.7. Data analysis

Descriptive statistics

Descriptive statistics are utilised in data exploration; they provide insights into data distribution, measures of central tendency, and data variability.

Furthermore, descriptive statistics are employed in this study to compare the UK students' mean scores against the international OECD benchmark. ICT variables recorded in Warm's likelihood estimate (WLE) are standardised to OECD mean scores of 0 and a standard deviation of 1. Consequently, the means are used to compare the UK students' mean scores to the international OECD mean scores.

When the means are negative, it implies that students responded less positively than the average of all respondents across OECD countries, and a positive value indicates that students responded more positively on average than all respondents across OECD countries. (OECD, 2019a)

For ordinal variables with categorical measurements, ICT levels are assessed using distribution-based descriptions, specifically frequency and percentage distributions across response categories

Inferential statistics

Inferential statistics are employed to draw conclusions about hypotheses examining relationships between ICT variables and academic performance, as well as differences in ICT by demographic variables.

To examine the relationship between ICT and academic performance, multiple linear regression is employed. Multiple linear regression is used to assess the relationship between a dependent variable and one or more independent variables. The equation that describes how the dependent variable y is related to the independent variables X_1, X_2, ..., X_n, along with an error term, is known as the multiple regression model, expressed below. (Thrane, 2024).

$$y = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_n x_n + e$$

[1]

When interpreting regression model results, it is important to note that, in large samples such as PISA, caution must be exercised regarding the statistical significance of regression coefficients. This is because larger samples tend to make all coefficients statistically significant due to smaller standard errors. Therefore, reliance solely on significance levels is insufficient for evaluating the importance of independent variables in the model(Thrane, 2019). Therefore, we analyse both the unstandardized coefficient B and the standardised coefficient beta to evaluate the magnitude and direction of the association.

Furthermore, to compare differences in ICT across gender, socioeconomic status, and school type, nonparametric tests such as the Mann-Whitney U test and the Kruskal-Wallis test are employed. These tests serve as nonparametric alternatives for variables that do not meet the assumptions required for ANOVA and independent t-tests. (Naghshpour, 2016).

While weighing PISA data is essential for generating unbiased population estimates, non-parametric tests in IBM SPSS, such as Mann-Whitney and Kruskal-Wallis, do not properly support probability sampling weights used by PISA; therefore, the findings for the demographic and socioeconomic disparities are exploratory of the UK PISA 2018 sample rather than UK weighted national population estimates.

3. Literature Review

This section presents the study's background and reviews prior studies on students' familiarity with ICT, drawing on data from relevant academic sources.

3.1. Background of the study

3.1.I.1. ICT Familiarity Concept

ICT familiarity constitutes a multidimensional construct encompassing students' access to digital devices, usage frequency, exposure, competence, interest, and technological autonomy. The PISA framework assesses ICT familiarity through various interconnected components that capture both objective behaviours and subjective perceptions. Comprehending this conceptualisation is vital for interpreting how students engage and utilise digital tools for educational purposes (Silva et al., 2023).

The fundamental level of ICT familiarity includes access to digital devices and internet connectivity at home and at school. Studies acknowledge that mere access is insufficient to understand the educational association between technology and academic achievement. As a result, the concept has advanced to encompass the quality and intent of use, differentiating between ICT employed for entertainment and that used for educational purposes across various settings.

This differentiation is crucial, as empirical evidence consistently shows that different modalities of ICT utilisation exhibit distinct correlations with academic achievements. (Agasisti et al., 2020).

Beyond behavioural dimensions, ICT familiarity encompasses a psychological construct that includes perceived competence, which refers to the student's ability to perform various ICT tasks; perceived autonomy, the sense of control over technology use; and perceived interest in ICT. (Petko et al., 2016). These psychological constructs, grounded in self-determination theory, facilitate an understanding of the relationship between ICT use and learning outcomes. (Yu et al., 2023). The PISA familiarity questionnaire evaluates these constructs utilising a validated OECD scale, thereby enabling cross-national comparison.

3.2. Theoretical Frameworks

To comprehend the concepts of ICT familiarity and academic achievement, the following theoretical frameworks provide a foundation for understanding the relationships, mechanisms, and disparities involved.

3.2.I.1. Digital Divide theory

The theory of the digital divide has evolved from early concerns regarding access disparities, which constitute the initial level of the digital divide, to a more nuanced understanding that encompasses usage gaps and skills disparities, which constitute the second level of the digital divide(Ragnedda & Muschert, 2013). Research indicates that even when access to technology is relatively equitable, notable disparities persist in how students use ICT, the benefits and the skills they acquire. Such disparities are consistently associated with factors such as socio-economic status, cultural capital, and educational environments, all of which continue to influence educational inequalities(Ferraro, 2018).

This study applies the digital divide theory to analyse disparities in ICT use for academic purposes, considering demographic factors such as students' gender, school type, and socio-economic status. To help us understand the second-level of the digital divide among students in the UK.

3.2.I.2. The technology acceptance model (TAM)

This theoretical model recognises two beliefs as fundamental principles in technology acceptance, which could aid in understanding the interrelation between ICT perception and usage.

The first belief is the perceived usefulness; this refers to the extent to which students believe that utilising technology will enhance their performance. The second belief is the perceived ease, the extent to which students believe that using technology will make work easy and require minimal effort. (Davis, 1989) These beliefs provide insight into which ICT perceptions are positively associated with academic achievement in science and mathematics.

The context of TAM in this study is reflected in students' perceived ICT autonomy, which could serve as a proxy for ease of use, while ICT interest reflects the perceived value. Therefore, TAM is pertinent to this study as it assists in understanding which belief exhibits a positive correlation with academic achievements.

3.2.I.3. Self-determination theory

This theory provides a psychological framework for comprehending motivation and engagement with ICT. It posits that intrinsic motivation, fostered by perceptions of competence, autonomy, and relatedness, results in enhanced engagement and improved learning outcomes(Yu et al., 2023). Applying the SDT to the context of ICT familiarity, the theory suggests that students' perceived interest in ICT impacts their motivation to utilise technology for educational purposes. This motivation, in turn, influences their actual usage of ICT in learning, which subsequently affects the relationship between ICT and academic outcomes. (Petko et al., 2016). The SDT model is essential for explaining the relationship among ICT attitudes, usage patterns, and performance (Zhang & Gu, 2023).

These theoretical models offer a structured approach to examine the psychological and behavioural factors influencing students' familiarity with ICT, focusing on how their attitudes relate to their overall ICT skills usage. They provide insights into how personal perceptions and social learning, such as confidence in using digital tools, can encourage the use of ICT to develop cognitive skills. Furthermore, these models form a valuable framework for understanding how various types of ICT usage can lead to different associations (Sze Ming Loh et al., 2025), providing a theoretical hypothesis regarding whether the perception of behaviour and the utilisation of ICT are associated with academic achievements, or if certain uses are more beneficial than others.

3.3. ICT Familiarity and Academic Achievements

The Organisation for Economic Co-operation and Development (OECD), through the Programme for International Student Assessment (PISA), has played a pivotal role in evaluating students' ICT familiarity and its relation to achievement in core subjects such as mathematics and science (van der Vlies, 2020).

According to OECD (2024) the relationship between ICT use and academic outcomes is complex, while technology can enhance engagement and access to learning materials. Excessive or unfocused use can lead to distractions and reduced performance. Hence, recent research emphasises not only access to technology but also the quality and purpose of ICT use as determinants of learning effectiveness (Lim & Kreijkes, 2025).

Regarding ICT familiarity and academic achievements, ICT use in schools aims to improve students' ability to use digital tools for complex academic tasks. (Ma & Cheng, 2022). Understanding these significant distinctions in the utilisation of ICT within and outside the classroom for educational purposes, and their association with students' academic performance, may facilitate the identification of ICT indices that exhibit positive or negative relationships with academic outcomes.

The expansion of ICT in education has served as both a driver and a challenge to educational quality. International studies utilising PISA datasets reveal diverse outcomes. OECD reported that moderate, purposeful ICT use, such as using digital tools for simulations or problem-solving, tends to be positively associated with student performance in mathematics and science. However, very high or unfocused ICT use is often associated with lower performance, illustrating an "inverted-U" relationship. (OECD, 2023)

(Courtney et al., 2022) found that while students' ICT confidence and access enhance digital literacy, excessive device use at home for entertainment is negatively related to mathematics performance. Similarly, (Acun Çelik et al., 2024) found that ICT competence, rather than mere frequency of use, predicts success across science and mathematics literacy domains. These findings suggest that ICT familiarity in relation to academic use must be interpreted in terms of how technology is used for school purposes.

3.3.I.1. Global perspective of ICT familiarity and Academic Performance.

Globally, the OECD (PISA, 2019) has also cautioned that without structured pedagogical integration and teacher support, technology's educational benefits remain limited. Thus, the global evidence highlights three consistent trends: (1) moderate and targeted ICT use benefits learning, (2) overuse may hinder academic outcomes, and (3) teacher competence and guided use are essential mediators between ICT familiarity and achievement.

Studies across Europe indicate that the impact of ICT on educational outcomes depends on context, teaching quality, and the integration of digital literacy. According to Denoël et al. (2017), European students who used the internet moderately (1–4 hours daily) performed better in science than both low-use and high-use groups, but beyond that threshold, outcomes declined. This indicates that optimal, purposeful use rather than heavy reliance enhances learning.

The European Commission (European Commission, 2016) similarly noted that although ICT infrastructure and internet connectivity are now nearly universal in EU schools, only a fraction of teachers receive mandatory ICT training. Consequently, schools with trained educators and structured ICT pedagogy outperform those that rely solely on access to technology. Research by Acun Çelik et al. (2024) also supports this, noting that students in European countries where ICT is integrated into science instruction through interactive simulations perform significantly better than those in countries emphasising technology for administrative or non-academic purposes.

Europe's experience underscores that pedagogical integration, teacher competence, and digital-literacy education are more important than hardware provision alone. As OECD (OECD, 2023b) concludes, education systems that focus on developing digital skills rather than simply increasing screen time yield greater and more sustainable improvements in mathematics and science outcomes.

3.3.I.2. ICT familiarity and academic performance: the United Kingdom perspective

The United Kingdom provides a unique case study in ICT familiarity due to its advanced technological infrastructure and high rates of digital access. Despite these advantages, performance trends in mathematics and science have not improved proportionally. According to the PISA 2022 (PISA 2022 Results, 2023a) UK Country Note, while device access is high and schools are wellequipped, students' mean scores in mathematics have remained stagnant since 2015, suggesting that access alone does not guarantee better performance outcomes.

Cambridge Assessment (Lim & Kreijkes, 2025) found that UK students' digital literacy and attitudes toward ICT use are stronger predictors of academic success than device usage frequency. Students who report higher confidence in using digital tools for learning, rather than for entertainment, achieve higher scores. These findings emphasise that the quality of ICT engagement, teacher support, and purpose-driven use are critical for improving outcomes.

3.4. Socio-Demographical Factors

The digital divide among students has been a persistent topic of research; many believed that in the twenty-first century, the digital gap would decrease significantly and eventually disappear, especially in schools. (Ma & Cheng, 2022).

Factors contributing to the digital divide among students in recent years are primarily associated with various disparities that have emerged compared to the past. Digital proficiency is frequently correlated with economic circumstances. Although numerous students have access to digital tools in school environments, especially in developed countries, their level of familiarity with ICT depends on how they utilise digital tools. This interaction frequency may vary among students depending on socioeconomic status, gender, and the type of school they attend, constituting the second level of the digital divide.

3.4.I.1. Gender Differences

The persistence of the gender-based digital divide in ICT familiarity, digital literacy, and skills is also an underlying factor contributing to disparities in the utilisation of ICT for cognitive skills. (Students, Computers and Learning, 2015)

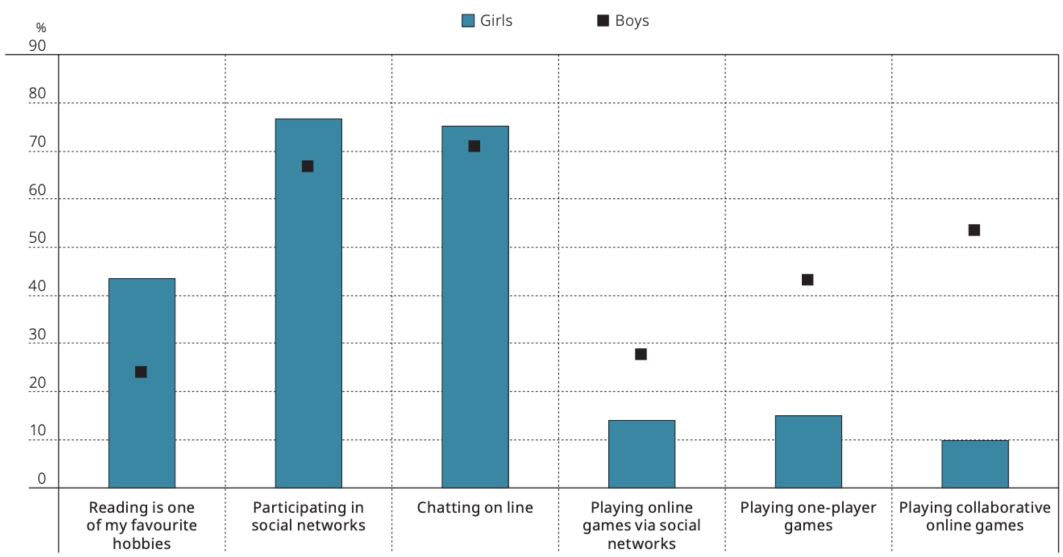
When assessing differences in ICT use and exposure, there is a clear pattern in how each gender engages with ICT activities. (Campos & Scherer, 2024) Research indicates that male students frequently exhibit higher perceived ICT competence and proficiency in computational thinking, whereas female students tend to excel in computer and information literacy. Additionally, students commonly use ICT resources and platforms differently by gender; female students exhibit higher levels of digital organisation and responsible use than male students (Maon et al., 2021). A study by Campos & Scherer (2024) shows similar results, indicating that boys often engage in gaming and various digital platforms, whereas girls are more inclined towards social networking and communication platforms.

Additionally, it was observed that boys generally spend more time on ICT and use it more for recreation, whereas girls are more inclined to use ICT for educational purposes. These gender differences in ICT familiarity may reflect the difference in how ICT is used. (Kunina-Habenicht & Goldhammer, 2020).

Research byEveline Gebhardt (2019) further explored the correlation between gender and computer information literacy, where males in 14 countries showed a stronger correlation, whereas most countries showed a weaker correlation for female students.

The PISA 2018 results depicted in Figure 1 illustrate the disparities in reading and ICT hobbies. Males and females exhibit different patterns of engagement with ICT hobbies, which may reflect ICT use for subject-related purposes.

Figure 1: Gender gap in ICT hobbies



Source: (OECD, 2019b)

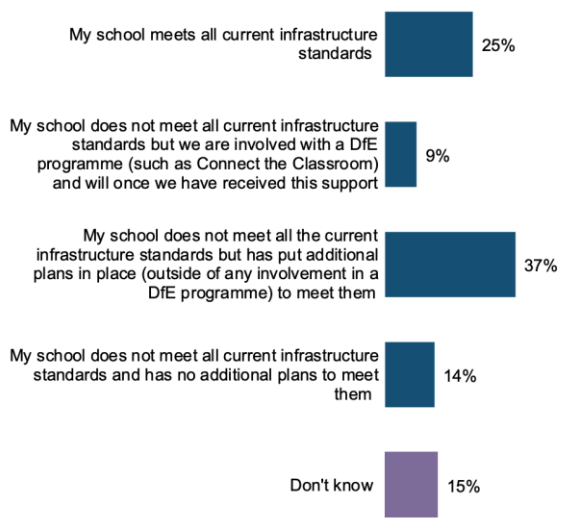
3.4.I.2. School-type ICT familiarity difference

The type of school attended could also play an important role in the ICT familiarity among students, with private institutions often giving students greater access to advanced technological infrastructure and specialized digital literacy teachers as compared to public schools(Students, Computers and Learning, 2015) such structural and access differences influences students opportunities in developing competency ICT skills and access that could contribute to the potential increase of the gap in ICT familiarity among students(Hossein-Mohand et al., 2021)

Furthermore, particularly in the United Kingdom, data indicate that some schools with ICT infrastructure do not meet current digital and technological standards. As a result, these schools experience slower access and limited digital device availability. This underscores the issue of digital stratification at the school level as an extension of the broader digital divide (Jisc, 2024) .

Figure 2 presents the report from the UK Department of Education, which inquired whether IT leaders in schools consider their institutions compliant with the current standards for digital and technological infrastructure.

Figure 2: Whether schools are meeting the digital and technology infrastructure.



Source: (Department of Education, 2025)

3.4.I.3. Socioeconomic status

3.4.I.3.1. Global context

Socioeconomic status is conceptualised as a combination of family income, parental education, parental occupation, and social or financial resources. In the context of ICT familiarity among students, SES influences both the first level of the digital divide, such as access to devices and connectivity, and the second level, which pertains to skills, usage, and outcomes. (Miras et al., 2023)

The variations in ICT availability across SES strata also extend to infrastructure quality, parental support, and opportunities for technology use outside school. These differences can contribute to how ICT familiarity differs among students.

ICT Familiarity among students is attributed to their frequency of access to devices and connectivity, which constitutes a mechanism associated with socio-economic status (SES). Previous research has shown that households with lower SES often own fewer devices, utilise older or outdated systems, and experience less stable Internet connectivity (Faith et al., 2022).This limits students' opportunities to engage with ICT at home, diminishing their exposure and practice and, consequently, likely affecting their engagement with ICT activities during school lessons.

Students from higher socioeconomic status (SES) backgrounds typically report greater self-efficacy in using ICT and have more exposure to cognitively demanding ICT tasks. Those with higher SES generally manage a wider range of tasks that develop digital skills, thereby increasing their familiarity with ICT. Conversely, students from lower SES backgrounds might have access to digital devices; however, they often engage more in routine or recreational activities rather than academic ones, which consequently limits their development of academic ICT skills. (Miras et al., 2023).

Research by Miras et al. (2023) has also shown the digital divide increase, emphasising that students' familiarity with ICT is not just device access but also skills and usage gaps, with SES remaining a significant factor. Furthermore, a JRC study on German students found that ICT literacy gaps are linked to SES, demonstrating that digital divides can be observed as early as age 8 and continue through secondary education (PASSARETTA Giampiero, 2022). Additionally, studies by ICIL (Fraillon, 2025) show that students from lower SES backgrounds have lower scores in computer and information literacy, lower self-efficacy, and less frequent use of digital tools for complex tasks as compared to their peers.

3.4.I.3.2. United Kingdom context

The UK sector emphasises that, despite improved school infrastructure and the availability of digital tools in all schools, families with lower incomes are still more likely to lack minimum digital standards than families with higher SES .

Integrating ICT in education, which aims to enhance living standards and academic achievement in the digital age, remains an ongoing area of research concerning the effectiveness of such investment mechanisms. (Y. Wang & Wang, 2023).

The ongoing expansion of ICT research across vocational, primary, and secondary educational institutions has highlighted an unequal distribution of ICT access globally. This disparity exhibits variation between developed and developing countries. In developed nations such as the UK, disparities in ICT proficiency among students from different regions persist, motivating numerous schools to implement innovative strategies for incorporating ICT into educational curricula to address the regional inequality gap. (Digital Equity and Inclusion in Education, 2023). This difference is attributed to factors such as socioeconomic status, which vary by region and could affect how students engage with technology.

The studies suggest that students from lower-SES backgrounds may lack access to digital devices and stable internet connections. However, with the recent widespread availability of affordable digital technology, improved internet connectivity, and the adaptation of E-learning platforms, most students in developed countries like the UK now have access to the internet and digital devices. Therefore, disparities in the digital divide could be viewed as a second level of disparities, involving usage

3.5. Conclusion Of Literature Review

The literature indicates that familiarity with Information and Communication Technology (ICT) is a comprehensive concept shaped by diverse digital elements, including exposure, usage, and perception. Although digital access has considerably expanded, particularly in developed nations such as the UK, research suggests that merely obtaining access does not ensure improved learning outcomes. The educational efficacy of ICT depends on deliberate, purposeful engagement aimed at achieving academic achievements.

The theoretical frameworks further explain how disparities in socioeconomic background, gender, and school environment influence ICT engagement, which in turn shapes students' confidence and motivation to utilise technology for academic purposes. Although the gap in ICT usage by gender, socioeconomic status (SES), and school persists, studies indicate that these differences are related to use rather than merely access.

The literature suggests that familiarity with ICT is primarily associated with academic performance through autonomous engagement with learning tasks, thereby enhancing cognitive skills. These insights serve as the basis for the practical component, guiding us in which aspects of ICT familiarity are relevant to our study and identifying ICT dimensions likely to be related to mathematics and science.

4. Practical Part

This section covers the practical part of the thesis, including variable presentation, data transformation, and data analysis.

4.1. Data presentation

The PISA 2018 student questionnaire and school dataset were downloaded from the official website. The two datasets were merged using a one-to-many merge with the key variable country ID (CNTRYID). Students were assigned to their respective schools using the school ID (CNTSCHID). After merging the datasets, the United Kingdom was selected by applying the condition CNT=826. This dataset is the only one utilised for data analysis of this study.

A total of 13,818 students from the United Kingdom participated in the 2018 PISA cycle, including 6,996 females and 6,822 males. However, after applying the necessary weights to adjust for non-response students (W_FSTUR), the total number of students increased to 597,240 (307,270 females and 289,970 males), representing the UK student population estimate. Weighting the data is essential to produce unbiased population estimates for comparing mean scores standardised across the OECD population, which are used in descriptive comparisons of means.

4.2. Variables

The following variables were carefully selected for use of further analysis.

1) ICT variables

Since ICT familiarity is a multidimensional concept, it involves analysing multiple variables to accurately capture students' ICT familiarity across different aspects.

I. Access and exposure**:** these variables reflect ICT access and exposure.

- IC002Q01HA (Age at first use of digital device)
- ICT available in school
- ICT available at home

II. ICT use: these variables represent the use of ICT in the learning context, subject-related use, and engagement.

- ICT class- subject-related use of ICT in class during lessons
- ICT outside –subject-related use of ICT outside lessons

III. Attitude and dispositions; these are psychological variables that represent the student's self-reported ICT familiarity.

- Perceived ICT confidence
- Perceived ICT autonomy
- Perceived ICT interest

2) Academic achievement variables:

Academic achievement variables are not reported as a single test score; instead, they are estimated using 10 plausible values for each subject. These are the likely scores that account for measurement of uncertainty.

- Mathematics plausible value 1- mathematics plausible value 10
- Science plausible values 1- science plausible value 10

3) demographic and socio-economic variables

- Gender
- Index of economic, social, and cultural status (ESCS)
- School-type (public or private)

4.3. Data transformation

The PISA dataset was prepared extensively before conducting the statistical analysis. The missing values were systematically identified and already marked in the dataset. Cases with missing data were excluded using listwise deletion, retaining only students with complete data to ensure consistent sample composition.

To examine differences in economic, social, and cultural status with ICT familiarity, and to satisfy the requirements of the non-parametric group test, the original continuous ESCS index was transformed into a categorical grouping variable. The continuous scale was converted into four quartiles using a percentile-based binning procedure. The data were divided at the 25^{th}, 50^{th} and 75^{th} percentiles to create four distinct ordinal categories, with the bottom quarter representing socially and economically disadvantaged students, and the top quarter representing the most socially and economically advantaged students. The transformed ESCS variable was only used in the Kruskal-Wallis test and not in any other models.

4.4. Descriptive Statistics of ICT Familiarity Levels

This section analyses the selected ICT variables to assess the level of ICT familiarity in the UK, using descriptive statistics to compare mean scores with the OECD average. Therefore, the weight to adjust for non-response among students was used to present the UK student population estimate.

Access and Exposure.

1. The variable IC002Q01HA is an ordinal categorical variable that captures the meaningful order of the age at which students first engaged with digital devices such as laptops, smartphones, tablets, and game consoles.

Table 1: frequency table of IC002Q01HA

How old were you when you first used a digital device?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 years old or younger	78687	13.2	14.8	14.8
	4-6 years old	118822	19.9	22.3	37.1
	7-9 years old	269465	45.1	50.6	87.7
	10-12 years old	60957	10.2	11.4	99.1
	13 years old or older	4270	0.7	0.8	99.9
	I have never used a digital device until today	444	0.1	0.1	100.0
	Total	532644	89.2	100.0	
Missing	No Response	64595	10.8		
Total		597240	100.0		

Source: author

Table 2:descriptive statistics of IC002Q01HA

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
How old were you when you first used a digital device?	503121	1	6	2.75	.986
Valid N (listwise)	503121				

Source: author

The data above illustrates the age at which students in the UK initially engage with digital devices. The data indicate a mean score of 2.75 and an SD of 0.986 on the categorical scale. Overall, 87.7% of students first used digital devices by age 9, while 99.1% by age 12. Only 0.8% reported their first access to digital devices at age 13 or older, while 0.1% reported never using digital devices at all.

2. ICT availability at home is the presence of ICT resources in students' homes; it is a discrete numerical variable ranging from 1 to 11.

Table 3: frequency table of ICT-home

ICT available at home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	0.0	0.0	0.0
	3	67	0.0	0.0	0.0
	4	4421	0.7	0.7	0.8
	5	21964	3.7	3.7	4.5
	6	45570	7.6	7.7	12.2
	7	75852	12.7	12.8	25.0
	8	117030	19.6	19.8	44.8
	9	132868	22.2	22.5	67.2
	10	128079	21.4	21.6	88.9
	11	65798	11.0	11.1	100.0
	Total	591662	99.1	100.0	
Missing	No Response	5577	0.9		
Total		597240	100.0		

Source: author

Table 4: descriptive statistics of ICT-home

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ICT available at home	591662	1	11	8.57	1.632
Valid N (listwise)	591662				

Source: author

The frequency distribution table shows that most students report having 9 ICT resources at home, accounting for 22.5% of the population estimate. Low availability of ICT resources at home is rare, with only a marginal 80 students having 1-3 ICT resources at home. The mean score is 8.57, with a standard deviation of 1.63.

3. ICT availability at school is a variable that represents the availability of ICT resources. This variable is used to measure the students' access to technology in school; it is a discrete numeric variable ranging from 0 to 10.

Table 5: frequency table of ICT-school

ICT available at school

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	315	0.1	0.1	0.1
	1	397	0.1	0.1	0.1
	2	620	0.1	0.1	0.2
	3	1958	0.3	0.3	0.6
	4	2753	0.5	0.5	1.0
	5	59977	10.0	10.2	11.3
	6	127417	21.3	21.8	33.0
	7	180165	30.2	30.8	63.8
	8	108304	18.1	18.5	82.3
	9	58593	9.8	10.0	92.3
	10	44950	7.5	7.7	100.0
	Total	585449	98.0	100.0	
Missing	No Response	11790	2.0		
Total		597240	100.0		

Source: author

Table 6: descriptive statistics of ICT-school

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ICT available at school	585449	0	10	7.15	1.433
Valid N (listwise)	585449				

Source: author

The availability of ICT resources in the school is moderate. Approximately 30.8% of students reported having access to 7 ICT resources at school. Most students, around 71.1%, indicated having between 6 and 8 ICT resources. Additionally, 99% of students have access to at least 5 ICT resources at school, with 0.1% having no ICT resources; the average is 7.15 resources, and the mode is 7.

ICT Use and Perception

The variables interest in ICT, ICT perceived autonomy, ICT perceived competence, ICT-class, ICT-outside, and social-ICT are continuous latent variables derived using Item Response Theory (IRT), reported as Warm Likelihood Estimates (WLE). They are standardised to a mean of 0 across the OECD.

4. ICT perceived autonomy is the extent to which a student has autonomy over the use of technology, providing insight into the student's independence and control when using technology, especially in learning or problem-solving situations

Table 7: descriptive statistics of perceived autonomy

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived autonomy related to ICT use (WLE)	440229	-2.5144	2.0258	0.084089	0.9617032
Valid N (listwise)	440229				

Source: author

5. The interest in ICT variable is the student's intrinsic motivation and engagement with technology, it examines the degree to which the student enjoys ICT.

Table 8: descriptive statistics of perceived ICT-INTEREST

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Interest in ICT (WLE)	451249	-2.9362	2.6672	0.304580	0.9593835
Valid N (listwise)	451249				

Source: author

6. Perceived ICT competence is a measure of a student's self-efficacy in performing digital tasks independently.

Table 9: descriptive statistics of perceived ICT-competence

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived ICT competence (WLE)	444474	-2.6033	2.0652	0.300440	0.9494461
Valid N (listwise)	444474				

Source: author

7. The ICT-class variable examines the use of ICT in class for subject-related purposes.

Table 10: descriptive statistics of ICT-class

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Subject-related ICT use during lessons (WLE)	482890	-1.2188	2.4394	-0.241278	0.9384933
Valid N (listwise)	482890				

Source: author

The perceived ICT autonomy, as shown in Table 7, has a mean of 0.08 and a standard deviation of 0.96, implying that students in the United Kingdom are marginally above the OECD average in this domain.

The results in Tables 8 and 9 demonstrate that students' interest in ICT and perceived competence have means of 0.305 and 0.30, respectively, with standard deviations of 0.96 and 0.95, respectively. The positive mean values suggest that, on average, students in the UK report slightly higher levels of ICT interest and perceived competence compared to the OECD average, which is standardised to zero.

Conversely, ICT use in class exhibits means below the OECD average. Table 10 reports a mean of -0.24 for ICT use in classrooms, The negative value suggest that students in the United Kingdom utilise ICT less frequently in classrooms.

4.5. Multiple linear regression analysis: Relationship Between ICT Use and Academic Performance in Mathematics and Science

In the multiple linear regression models, the categorical variable, gender, is dummy-coded, with 'female' as the reference group.

To determine whether a statistically significant relationship between ICT familiarity and academic achievement exists, we evaluate p-values against the threshold of 0.05; we reject the null hypothesis when $p<0.05$.

Hypothesis

Null hypothesis 1: There is no relationship between mathematics performance and ICT class-subject, ICT outside, controlling for gender and ESCS.

Alternative hypothesis: At least one of the variables (ICT class and ICT outside) has a relationship with mathematics performance, controlling for gender and ESCS.

In this multiple regression model, the dependent variable is mathematics plausible values (PV-math), and the independent variables are ICT-outside (ICT use outside of lessons for subject-related) and ICT class (Subject-related ICT use during lessons), controlling for gender and ESCS.

Table 11: descriptive statistics of ICT uses and mathematics.

variables	*n*	*Weighted N*	*mean*	*SD*
ESCS	6600	446899	0.29	0.91
Ict-class	6600	446899	-0.23	0.94
Ict-outside	6600	446899	0.34	0.95
PV-Math	6600	446899	511.29	91.17
Gender (males)	6600	446899	0.46	0.49

Source: author

Table 12: model summary of ICT uses and mathematics.

R-Square	*R-square (S.E)*	*Adjusted R-Square*	*Adjusted R-square (S.E.)*
0.13	0.014	0.13	0.014

Source: author

Table 13: coefficients of ICT use and mathematics.

Variables	*B*	*S. E*	*Beta*	*t-value*	*p-value*
(Constant)	489.97	3.05		160.72	0.001
ESCS	32.23	1.89	0.32	16.99	0.001
ICT class	1.27	2.05	0.01	0.62	0.53
ICToutside	10.27	1.76	0.11	5.83	0.001
Gender (males)	18.04	3.39	0.09	5.32	0.001

Source: author

From the results of Table 13, we can construct a regression equation

$$y' = 489.97 + 32.23X_{ESCS} + 1.27X_{ICTclass} + 10.27X_{ICToutside} + 18.04D_{males}$$

[2]

The multiple regression model has an R² of 0.13 and an adjusted R² of 0.13, explaining only 13% of the variance in mathematics achievement. The unstandardized coefficients (B) in the model indicate the relationship between each variable with mathematics performance, while holding other variables constant. The intercept of 489.97 is the expected mathematics score for a female student (the reference group for gender) with average ESCS, and uses both ICT inside and outside the classroom at an average level compared to the OECD mean.

The control variables are significantly associated with mathematics achievement; each 1-unit increase in the ESCS predicts a 32.23-point increase in mathematics achievement. And male students score 18.04 points higher than female students.

A 1-unit increase in ICT use during lessons is associated with a 1.27-point increase in achievement. Similarly, a 1-unit increase in ICT use outside school for subject-related purposes is associated with a 10.27 points increase.

The p-values for ESCS, gender, and ICT outside class are < 0.05; therefore, they are statistically significant and associated with mathematics achievement. In contrast, the p-value for the ICT class is >0.05; therefore ICT class is not statistically significant.

To evaluate the strength of the relationship, we examine standardised beta coefficients. ESCS ($\beta = 0.32$) exhibits the strongest association with mathematics scores, followed by ICT outside class ($\beta = 0.11$) and gender ($\beta = 0.09$). Although ICT use in class ($\beta = 0.01$) is positively associated, it is not statistically significant.

Based on these findings, we reject null hypothesis 1 because at least one independent variable is related to mathematics.

Hypothesis 2

Null hypothesis 2: There is no statistically significant relationship between science performance and ICT use in class, subject-related use and ICT outside- subject, controlling for ESCS and gender.

Alternative hypothesis 2: at least one of the variables, ICT use in class-subject, ICT-outside) has a relationship with science performance, controlling for ESCS and gender.

The multiple regression model uses student science plausible values (PV-science) as the dependent variable. The independent variables include ICT-outside (use of ICT outside class for subject-related purposes) and ICT-outside (use of ICT outside for subject-related purposes). Gender and ESCS are control variables.

Table 14:descriptive statistics of ICT uses and science.

Variables	*n*	*Weighted N*	*mean*	*SD*
ESCS	6600	446899	0.29	0.90
ICTclass	6600	446899	-0.23	0.94
ICToutside	6600	446899	0.34	0.95
PV-Science Scores	6600	446899	516.00	96.71
Gender (males)	6600	446899	0.13	0.49

Source: author

Table 15:model summary of ICT uses and science.

R-square	*R-square (S.E)*	*Adjusted R-square*	*Adjusted R-square (S.E)*
0.11	0.01	0.11	0.01

Source: author

Table 16: coefficients of ICT use and science.

variables	*B*	*S. E*	*Beta*	*t-value*	*p-value*
Constant	498.79	2.74		181.73	0.001
ESCS	33.14	2.17	0.31	15.26	0.001
ICTclass	-0.31	1.85	-0.003	-0.16	0.86
ICToutside	10.88	1.67	0.11	6.48	0.001
Gender (males)	7.50	3.43	0.04	2.21	0.027

Source: author

From table16 we can construct a regression equation.

$$y' = 498.79 + 33.14X_{ESCS} - 0.31X_{ictclass} + 10.88X_{ictoutside} + 7.50D_{males}$$

[3]

The multiple linear regression model has an R^2 of 0.11, indicating it explains only 11% of the variance in science scores. Table 16 shows that the control variable ESCS has a stronger positive relationship than the other independent variables. ESCS has a p-value < 0.05 and a B coefficient of 33.14, indicating a 33.14 increase in science achievement for each one-unit increase in ESCS, with a predictive power of 0.31, suggesting it is the strongest predictor in the model.

Gender correlates with science achievement ($p < 0.05$, $B = 7.50$), indicating that males score 7.50 points higher than females. Gender has weak predictive power for science performance, with a standardised beta of 0.04.

Controlling for gender and ESCS, the use of ICT outside class is significantly related to science performance (p-value =0.001, B = 10.88), with an effect size (= 0.11). In contrast, ICT use in class shows no significant association with science performance (p = 0.86; B =-0.31), indicating a decrease of 0.31 for each unit increase, with a negative effect size (-0.003).

Based on these findings, we reject null hypothesis 2, because at least one independent variable is related to science achievement.

4.6. Multiple-Regression: Better Academic Achievement Predictor

To assess which ICT variable is a stronger predictor of academic outcomes, the Pearson correlation test was first conducted to examine correlations among psychometric variables. The dependent, independent, and control variables were included in the model.

Table 17: Pearson correlation

Variable	*ICT-Interest*	*ICT-competence*	*ICT-autonomy*	*gender*	*ESCS*	*PV-science*	*PV-mathematics*
ICT-interest	1.00	0.47	0.41	0.02	0.04	0.004	0.01
ICT-competence	0.47	1.00	0.658	0.19	0.08	0.07	0.10
ICT-autonomy	0.41	0.658	1.00	0.24	0.07	0.08	0.11
Gender	0.02	0.19	0.24	1.00	0.02	0.03	0.09
ESCS	0.04	0.08	0.07	0.02	1.00	0.31	0.33
PV-science	0.004	0.07	0.08	0.03	0.32	1.00	-
PV-mathematics	0.01	0.10	0.11	0.09	0.33	-	

Source: author

The results indicate weak correlations among most independent variables, including the control variables. The only notable exception is the positive correlation between perceived ICT-competence and perceived ICT-autonomy, with r = 0.658. Although 0.658 is a strong correlation, it is still below the 0.70 threshold it is included in the model. All variables were included in a multiple linear regression to evaluate their predictive power.

Mathematics Hypotheses

Null hypothesis 3: ICT autonomy is not a significant predictor of mathematics achievement, controlling for gender and ESCS.

Alternative hypothesis 3: ICT autonomy is a significant predictor of mathematics achievement, controlling for gender and ESCS.

Null hypothesis 4: ICT interest is not a significant predictor of mathematics achievement, controlling for gender and ESCS.

Alternative hypothesis 4: ICT interest is a significant predictor of mathematics achievement, controlling for gender and ESCS.

Null hypothesis 5: ICT competence is not a significant predictor of mathematics achievement, controlling for gender and ESCS.

Alternative hypothesis 5: ICT competence is a significant predictor of mathematics achievement, controlling for gender and ESCS.

Table 18;model summary

R-square	*R-square(s.e.)*	*Adjusted R-square*	*Adjusted R-square (s.e.)*
0.13	0.01	0.13	0.01

Source: author

Table 19: regression coefficients

variable	*B*	*S. E*	*Beta*	*t-value*	*p-value*
constant	497.61	2.83		176.00	0.001
ICT-interest	-4.84	2.00	-0.05	-2.43	0.015
ICT-competence	4.33	2.51	0.04	1.72	0.085
ICT-autonomy	5.71	2.29	0.06	2.49	0.013
ESCS	33.09	1.90	0.33	17.41	0.001
Gender(male)	12.71	3.71	0.07	3.43	0.001

Source: author

The independent variables explain only 13% of the variance in mathematics scores, as shown by R^2 of 0.13.

Table 19 shows ICT autonomy with a p-value <0.05, indicating a statistically significant relationship, therefore, we reject null hypothesis 3. To evaluate ICT autonomy's ability to predict mathematics, the beta coefficient is 0.06, indicating a relatively positive effect with a 5.71 increase in mathematics for every 1 unit increase.

ICT interest reports: B = -4.84 and β = -0.05, suggesting that ICT interest does not positively predict mathematics performance, with a p-value below 0.05; therefore, we reject null hypothesis 4. The negative coefficients indicate an inverse relationship between mathematics achievement and ICT interest, meaning higher ICT interest is associated with lower mathematics scores. Specifically, a 1-unit increase in ICT interest corresponds to a 4.84-point decrease in mathematics achievement.

ICT competence reports B=4.33, β=0.04 p=0.085, these results suggest that ICT competence is not a predictor of mathematics achievements therefore we fail to reject the null hypothesis 5, ICT competence does not predict mathematics achievements, although it has a positive direction with coefficient B=4.33 β= 0.04 suggesting a potential link between ICT competence and mathematics, the relationship consequently does not reach a statistical significant relationship.

Science Hypotheses

Null hypothesis 6: ICT autonomy is not a predictor of science achievement, controlling for gender and ESCS.

Alternative hypothesis 6: ICT autonomy predicts science achievement, controlling for gender and ESCS.

Null hypothesis 7: ICT interest is not a predictor of science achievement, controlling for gender and ESCS.

Alternative hypothesis 7: ICT interest predicts science achievement, controlling for gender and ESCS.

Null hypothesis 8: ICT competence is not a predictor of science achievement, controlling for gender and ESCS.

Alternative hypothesis 8. ICT competence predicts science achievement, controlling for gender and ESCS.

Table 20; model summary

R-square	*R-square(s.e.)*	*Adjusted R-square*	*Adjusted R-square (s.e.)*
0.11	0.01	0.11	0.01

Source: author

Table 21;coefficients

variable	*B*	*S. E*	*Beta*	*t-value*	*p-value*
constant	508.04	2.86		177.67	0.001
ICT-autonomy	6.17	2.33	0.06	2.65	0.008
ICT-competence	3.21	2.64	0.03	1.22	0.2
ICT-interest	-4.53	2.20	-0.05	-2.22	0.026
ESCS	33.37	2.17	0.31	15.40	0.001
Gender(male)	1.82	3.67	0.01	0.50	0.61

Source: author

The model with an R^2 of 0.11 explains 11% of the variance in science scores accounted for by the independent variables.

ICT autonomy has a coefficient of B=6.17, β=0.06, p-value <0.05, indicating a statistically significant positive association with science performance; a 1-unit increase in ICT autonomy corresponds to a 6.17-point increase in science scores. Therefore, we reject the null hypothesis 6

ICT interests have B = -4.53, β = -0.05, p-value < 0.05, which is statistically significant; therefore, we reject null hypothesis 7. However, it negatively predicts science achievement; a 1-unit increase in ICT interest decreases science achievement by 4.53 points.

Conversely, ICT competence shows B=3.21, β=0.03, p-value > 0.05, suggesting we fail to reject the null hypothesis 8. This indicates that ICT competence is not a statistically significant predictor of science achievement, despite a positive estimate of 0.03, indicating limited predictive power.

4.7. The Difference in ICT Familiarity, Demographic Factors and Socioeconomic Status.

To examine differences in ICT familiarity across gender, ESCS, and school type, the variables were tested for parametric assumptions for t-tests and ANOVA; however, they did not meet the parametric requirements for these models. Therefore, the non-parametric alternative tests were employed. Additionally, the student weight was not applied in this analysis; therefore, these results do not represent an estimate of the UK population.

I. Mann Whitney u tests: ICT differences between genders

Null hypothesis 9: There is no statistically significant difference in ICT competence between males and females.

Alternative hypothesis 9: There is a statistically significant difference in competence between males and females.

Null hypothesis 10: There is no statistically significant difference in Subject-related ICT use during lessons between males and females.

Alternative hypothesis 10: There is a statistically significant difference in Subject-related ICT use during lessons between males and females.

Null hypothesis 11: There is no statistically significant difference in Subject-related ICT use outside of lessons between males and females.

Alternative hypothesis 11: There is a statistically significant difference in Subject-related ICT use outside of lessons between males and females.

Table 22: ranks for gender and ICT variables.

Ranks

	Student (Standardized) Gender	N	Mean Rank	Sum of Ranks
Perceived ICT competence (WLE)	Female	3269	2823.82	9231074.00
	Male	3000	3474.08	10422241.00
	Total	6269		
Subject-related ICT use during lessons (WLE)	Female	3269	3178.40	10390196.00
	Male	3000	3087.71	9263119.00
	Total	6269		
Subject-related ICT use outside of lessons (WLE)	Female	3269	3203.52	10472317.50
	Male	3000	3060.33	9180997.50
	Total	6269		

Source: author

Table 23: Mann Whitney u test for gender

Test Statistics

	Perceived ICT competence (WLE)	Subject-related ICT use during lessons (WLE)	Subject-related CT use outside of lessons (WLE)
Mann-Whitney U	3886259.000	4761619.000	4679497.500
Wilcoxon W	9231074.000	9263119.000	9180997.500
Z	-14.362	-1.998	-3.132
Asymp. Sig. (2-tailed)	<.001	.046	.002

a. Grouping Variable: Student (Standardized) Gender

Source: author

To test whether there is any difference in ICT familiarity between genders, the Mann-Whitney U

Perceived ICT competence has a p-value <0.05; therefore, we reject the null hypothesis 9. Males reported a mean rank of 3474.08, higher than females at 2823.82. The results suggest that males have greater confidence in their digital abilities than females.

Regarding subject-related ICT use during and outside lessons, females have higher mean scores in both categories, with a mean of 3178.40 for use during lessons, while males have a mean rank of 3087.71. Use of ICT outside lessons, females report a mean rank of 3203.52 compared to males at 3060.33. Both ICT use outside and in class have p-values <0.05, therefore, we reject the null hypotheses 10 and 11.

II. Mann Whitney u test: ICT differences between school-type

Null hypothesis 12: There is no statistically significant difference in ICT competence between students in private and public schools.

Alternative hypothesis 12: There is a statistically significant difference in ICT competence between students in private and public schools.

Null hypothesis 13: There is no statistically significant difference in Subject-related ICT use during lessons between students in private and public schools.

Alternative hypothesis 13: There is a statistically significant difference in Subject-related ICT use during lessons between students in private and public schools.

Null hypothesis 14: There is no statistically significant difference in Subject-related ICT use outside of lessons between students in private and public schools.

Alternative hypothesis 14: There is a statistically significant difference in Subject-related ICT use outside of lessons between students in private and public schools.

Table 24: Ranks for school-type and ICT variables.

Ranks

	Is your school a public or a private school?	N	Mean Rank	Sum of Ranks
Perceived ICT competence (WLE)	public school	2558	2573.01	6581756.50
	private school	2607	2592.80	6759438.50
	Total	5165		
Subject-related ICT use during lessons (WLE)	public school	2558	2617.59	6695796.00
	private school	2607	2549.06	6645399.00
	Total	5165		
Subject-related ICT use outside of lessons (WLE)	A public school	2558	2476.80	6335649.50
	A private school	2607	2687.21	7005545.50
	Total	5165		

Source: author

Table 25:Mann Whitney u test for school-type

Test Statistics

	Perceived ICT competence (WLE)	Subject-related ICT use during lessons (WLE)	Subject-related ICT use outside of lessons (WLE)
Mann-Whitney U	3308795.500	3245871.000	3062688.500
Wilcoxon W	6581756.500	6645399.000	6335649.500
Z	-.482	-1.664	-5.075
Asymp. Sig. (2-tailed)	.630	.096	<.001

Grouping Variable: Is your school a public or a private school?

Source: author

To assess whether ICT familiarity differs by school type, Table 25 shows ICT competence and ICT use during lessons, with p-values > 0.05, therefore, we fail to reject the null hypotheses 12 and 13. The reported mean ranks for competence are 2573.01 for public schools and 2592.80 for private schools. and the mean rank for ICT use during lessons is slightly higher in public schools at 2617.59, compared to 2549.06 in private schools.

Conversely, for ICT subject-related use outside of lessons, the p-value < 0.05. Therefore, we reject the null hypothesis 14, indicating a statistically significant difference in ICT-related use outside lessons between students from public and private schools, with mean ranks of 2476.80 for public schools and 2687.21 for private schools.

III. Differences in ICT familiarity based on ESCS.

Null hypothesis 15: There is no statistically significant difference between the students' ESCS group and ICT competence.

Alternative Hypothesis 15: There is a statistically significant difference between the students' ESCS group and ICT competence.

Null hypothesis 16: There is no statistically significant difference between the students' ESCS group and Subject-related ICT use during lessons.

Alternative Hypothesis 16: There is a statistically significant difference between the students' ESCS group and Subject-related ICT use during lessons.

Null hypothesis 17: There is no statistically significant difference between the students' ESCS group and Subject-related ICT use outside of lessons.

Alternative Hypothesis 17: There is a statistically significant difference between the students' ESCS group and Subject-related ICT use outside of lessons.

Table 26: ranks for ESCS.

Ranks

	Index of economic, social, and cultural status (Binned)	N	Mean Rank
Subject-related ICT use during lessons (WLE)	Bottom quarter	1684	3270.29
	Second quarter	1664	3376.15
	Third quarter	1759	3515.74
	Top quarter	1803	3642.95
	Total	6910	
Subject-related ICT use outside of lessons (WLE)	Bottom quarter	1610	3048.13
	Second quarter	1605	3243.19
	Third quarter	1691	3384.10
	Top quarter	1759	3626.56
	Total	6665	
Perceived ICT competence (WLE)	Bottom quarter	1577	3040.95
	Second quarter	1570	3266.32
	Third quarter	1666	3312.31
	Top quarter	1733	3454.31
	Total	6546	

Source: author

Table 27: Kruskal Wallis test

Test Statistics[a,b]

	Subject-related ICT use during lessons (WLE)	Subject-related ICT use outside of lessons (WLE)	Perceived ICT competence (WLE)
Kruskal-Wallis H	35.199	81.064	41.330
df	3	3	3
Asymp. Sig.	<.001	<.001	<.001

a. Kruskal Wallis Test

Grouping Variable: Index of economic, social, and cultural status (Binned)

Source; author

A Kruskal-Wallis H test was performed to examine significant differences in ICT usage and competence across four socio-economic groups. The statistical difference among ESCS groups are all significant at $p < 0.001$. Therefore, we reject the null hypotheses, 15,16 & 17. The mean ranks in Table 26 indicate that students from the top quartile report the highest perceived ICT competence (mean rank = 3454.31), ICT use in class (3642.95), and outside class (3626.56). Conversely, students from the bottom quartile report lower mean ranks for perceived competence (3040.95), in-class ICT use (3270.29), and outside-class ICT use (3048.13), with those from the second and third quartiles ranking in between.

5. Results And Discussions

This section discusses our findings from the practical part and the limitations.

5.1. ICT Familiarity

To evaluate ICT familiarity among students in the United Kingdom, the variables of access, exposure, engagement, use, attitude, and self-efficacy were analysed. The results suggest that the first level of digital divide in the UK is potentially minimal, as most students have access to ICT resources both at school and at home. Additionally, students are exposed to digital devices at an early age, which illustrates that the first level of the digital divide has been bridged in the UK.

Students' reports mean above the OECD average for interest in ICT and perceived competence, with a slightly above-average perceived autonomy. However, the use of ICT for subject-related during lessons is below the OECD average, despite the reported availability of numerous ICT resources within schools. This indicates that simply having ICT resources available does not necessarily lead to increased ICT use for educational purposes; the low use of ICT in class could be attributed to external factors not examined in this study, such as teachers' support.

5.2. Relationship between ICT-use and academic performance

The findings suggest that the relationship between ICT and academic performance depends on the context of use. Using ICT outside of class for subject-related activities is statistically significantly related to both science and mathematics performance, with a positive association, indicating that ICT use without teacher supervision for self-learning, completing homework, or conducting independent research is more effective than its use during lessons. Consequently, ICT use in class is positively associated with mathematics and negatively associated with science; however, it is not statistically significant at $p < 0.05$, therefore, we can not claim the association.

The use of ICT in class does not have a significant relationship with academic achievement. This could be attributed to the findings of students‘ low usage of ICT in class during lessons, which is below the OECD average.

.

5.3. Predictor of Mathematics and Science achievements

The findings emphasise that ICT autonomy is the most significant predictor of performance in mathematics and science. Conversely, the negative correlation observed with ICT interest suggests that such interest may not always reflect educational engagement but may instead be related to recreational use, thereby being negatively associated with academic achievement.

Furthermore, perceived competence likely indicates students' ability to operate various ICT technical skills rather than the higher-level cognitive skills required for effective ICT use in mathematics and science.

The positive associations of perceived ICT autonomy could be interpreted within the TAM framework, where students who feel more confident navigating ICT are more likely to use it effectively for learning.

The SDT theory is reflected in the intrinsic motivation of ICT. The negative relationship between ICT interest and academic achievements indicates that not all forms of intrinsic motivation translate into effective usage of ICT for educational purposes.

5.4. Differences in ICT Usage

The analysis reveals ICT familiarity across gender, school type, and ESCS group within the UK sample.

The findings show a significant difference between gender with male students reporting greater perceived competence in ICT. However, female students tend to use ICT more for academic purposes and may be more task-oriented in their digital engagement, focusing on curriculum-based learning. This aligns with the literature indicating that females often demonstrate higher performance in computer and information literacy than males.

The difference in ICT familiarity between private and public schools reveals an interesting finding: there is no statistically significant difference in perceived ICT competence or ICT use in lessons. This contrasts with the literature suggesting that private school students are more ICT-competent than their public school counterparts. The findings imply that the technology access gap has diminished, with both public and private schools sharing similar digitalisation mandates, thus providing students with comparable access and exposure during lessons. The perceived equality of competence may relate to generational traits driven by personal device ownership and exposure.

Students from private schools tend to use ICT more for subject-related activities outside of class compared to their public school peers. This may be due to differences in school projects and aligns with literature indicating that private school students use ICT more often for homework and assignments.

Additionally, the variation in ICT familiarity across ESCS groups reveals a digital divide, with students from higher ESCS backgrounds having greater advantages than those from lower ESCS backgrounds, consistent with existing research on the influence of background status on ICT familiarity.

6. Conclusion

The main objective of the study was to evaluate the level of ICT familiarity among UK students and its association with their academic performance in mathematics and science. It also sought to identify which psychometric variables best predict academic outcomes and to explore differences in ICT familiarity by gender, school type, and ESCS.

UK students can be considered native digital device users due to early exposure. However, ICT use and psychological factors do not significantly account for greater variation in academic achievement. Although a relationship exists between ICT variables and academic achievement, their explanatory power remains relatively weak in practice; other factors are more strongly associated with academic achievement than ICT variables.

Furthermore, differences in ICT familiarity by gender vary across different dimensions and uses. Variations by school type are minimal, suggesting that the digital divide has diminished over time, although inequalities related to socioeconomic status and student background persist.

In conclusion, ICT use and exposure do not demonstrate a stronger positive association with academic achievement in mathematics and science in practice, given the small effect size; other background factors, such as ESCS, have greater predictive power. The key factor in students' ICT familiarity and academic achievement lies in how they utilise ICT to develop learning skills and tackle complex tasks.

7. References

Acun Çelik, S., Özkan Elgün, İ., & Kalelioğlu, F. (2024). Assessment of student ICT competence according to mathematics, science, and reading literacy: evidence from PISA 2018. *Large-Scale Assessments in Education*, *12*(1), 30. https://doi.org/10.1186/s40536-024-00218-7

Agasisti, T., Gil-Izquierdo, M., & Han, S. W. (2020). ICT Use at home for school-related tasks: what is the effect on a student's achievement? Empirical evidence from OECD PISA data. *Education Economics*, *28*(6), 601–620. https://doi.org/10.1080/09645292.2020.1822787

Campos, D. G., & Scherer, R. (2024). Digital gender gaps in Students' knowledge, attitudes and skills: an integrative data analysis across 32 Countries. *Education and Information Technologies*, *29*(1), 655–693. https://doi.org/10.1007/s10639-023-12272-9

Courtney, M., Karakus, M., Ersozlu, Z., & Nurumov, K. (2022). The influence of ICT use and related attitudes on students' math and science performance: multilevel analyses of the last decade's PISA surveys. *Large-Scale Assessments in Education*, *10*(1), 8. https://doi.org/10.1186/s40536-022-00128-6

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Denoël, E., Dorn, E., Goodman, A., Hiltunen, J., Krawitz, M., Mourshed, M., Cheng, A., Duraikkannan, S., Koulikov, R., Sharma, D., & Vora, A. (2017). *Insights from Europe*. https://www.mckinsey.com/industries/education/our-insights/drivers-of-student-performance-insights-from-europe

Department of Education. (2025). *Technology in Schools survey: 2024 to 2025*. https://www.gov.uk/government/publications/technology-in-schools-survey-report-2024-to-2025

Digital equity and inclusion in education (OECD Education Working Papers, Vol. 299). (2023). https://doi.org/10.1787/7cb15030-en

European Commission. (2016). *2nd Survey of Schools: ICT in Education*. https://digital-strategy.ec.europa.eu/en/library/2nd-survey-schools-ict-education-0

Eveline Gebhardt, S. T. J. A. K. H. (2019). *Gender Differences in Computer and Information Literacy* (Vol. 8). Springer Nature.

Faith, B., Hernandez, K., & Beecher, J. (2022). *Digital Poverty in the UK*. https://doi.org/10.19088/IDS.2022.057

Ferraro, S. (2018). Is information and communication technology satisfying educational needs at school? *Computers & Education*, *122*, 194–204. https://doi.org/https://doi.org/10.1016/j.compedu.2018.04.002

Fraillon, J. (n.d.). *AN INTERNATIONAL PERSPECTIVE ON DIGITAL LITERACY Results from ICILS 2023 (Revised)*.

Fraillon, J. (2025). *An International Perspective on Digital Literacy : Results from ICILS 2023*. Springer. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=32437144

Hossein-Mohand, H., Gómez-García, M., Trujillo-Torres, J. M., Hossein-Mohand, H., & Boumadan-Hamed, M. (2021). Uses and resources of technologies by mathematics students prior to COVID-19. *Sustainability (Switzerland)*, *13*(4), 1–18. https://doi.org/10.3390/su13041630

Jisc. (2024). *Student digital experience insights survey 2023/24 UK higher education (HE) survey findings*. https://repository.jisc.ac.uk/9646/1/DEI-2024-student-he-report.pdf

Kunina-Habenicht, O., & Goldhammer, F. (2020). ICT Engagement: a new construct and its assessment in PISA 2015. *Large-Scale Assessments in Education*, *8*(1). https://doi.org/10.1186/s40536-020-00084-z

Lim, C. H. J., & Kreijkes, P. (2025). *Youth wellbeing, digital use and digital literacy: Evidence from PISA 2022 Research Report Author contact details*. https://www.cambridge.org/

Ma, J. K.-H., & Cheng, S. (2022). *Adolescent Well-Being and ICT Use : Social and Policy Implications*. Springer International Publishing AG. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=6998236

Maon, S. N., Hassan, N. M., Jailani, S. F. A. K., & Kassim, E. S. (2021). Gender Differences in Digital Competence Among Secondary School Students. *International Journal of Interactive Mobile Technologies*, *15*(4), 73–84. https://doi.org/10.3991/IJIM.V15I04.20197

Miras, S., Ruiz-Bañuls, M., Gómez-Trigueros, I. M., & Mateo-Guillen, C. (2023). IMPLICATIONS OF THE DIGITAL DIVIDE: A SYSTEMATIC REVIEW OF ITS IMPACT IN THE EDUCATIONAL FIELD. *Journal of Technology and Science Education*, *13*(3), 936–950. https://doi.org/10.3926/JOTSE.2249

Naghshpour, S. (2016). *A Primer on Nonparametric Analysis, Volume I*. Business Expert Press. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=4648712

OECD. (2009). *PISA data analysis manual : SPSS*. OECD.

OECD. (2015). *Students, Computers and Learning*. OECD. https://doi.org/10.1787/9789264239555-en

OECD. (2019a). *PISA 2018 Results (Volume II)*. OECD Publishing. https://doi.org/10.1787/b5fd1b8f-en

OECD. (2019b). *PISA 2018 Results (Volume II)*. OECD Publishing. https://doi.org/10.1787/b5fd1b8f-en

OECD. (2020). *PISA 2018 Technical Report*. https://www.oecd.org/en/about/programmes/pisa/pisa-data.html

OECD. (2023a). *PISA 2022 Results*. https://oecdch.art/a40de1dbaf/C341.

OECD. (2023b). *PISA 2022 Results*. https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/united-kingdom_9c15db47-en.html

OECD. (2024). *Managing screen time* (PISA in Focus, Vol. 124). https://doi.org/10.1787/7c225af4-en

PASSARETTA Giampiero, G. H. (2022). *The Early Roots of the Digital Divide: Socioeconomic Inequality in Children's ICT Literacy from Primary to Secondary Schooling*. https://publications.jrc.ec.europa.eu/repository/handle/JRC128931

Petko, Dominik, Cantieni, Andrea, & Prasse, Doreen. (2016). Perceived Quality of Educational Technology Matters: A Secondary Analysis of Students' ICT

Use, ICT-Related Attitudes, and PISA 2012 Test Scores. *Journal of Educational Computing Research*, *54*(8), 1070–1091. https://doi.org/10.1177/0735633116649373

PISA. (2019). *PISA 2018 Results (Volume I): What Students Know and Can Do*.

Ragnedda, M., & Muschert, G. W. (2013). *The Digital Divide : The Internet and Social Inequality in International Perspective*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=1221501

Sizmur, J., Ager, R., Bradshaw, J., Classick, R., Galvis, M., Packer, J., Thomas, D., & Wheater, R. (2019). *Achievement of 15-year-olds in England: PISA 2018 results*.

Sze Ming Loh, R., Kraaykamp, G., & van Hek, M. (2025). Do students' ICT skills pay off in math performance? Examining the moderating role of countries' ICT promotive environment. *European Educational Research Journal*, *24*(2), 129–146. https://doi.org/10.1177/14749041231201197

Thrane, C. (2019). *Applied Regression Analysis : Doing, Interpreting and Reporting*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=5945959

Thrane, C. (2024). *Statistical Analysis : The Basics*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/czup/detail.action?docID=31580116

van der Vlies, R. (2020). *Digital strategies in education across OECD countries* (OECD Education Working Papers, Vol. 226). https://doi.org/10.1787/33dd4c26-en

Wang, Y., & Wang, Y. (2023). Exploring the relationship between educational ICT resources, student engagement, and academic performance: A multilevel structural equation analysis based on PISA 2018 data. *Studies in Educational Evaluation*, *79*, 101308. https://doi.org/https://doi.org/10.1016/j.stueduc.2023.101308

Yu, Rushi, Wang, Meishu, & Hu, Jie. (2023). The Relationship Between ICT Perceived Competence and Adolescents' Digital Reading Performance: A Multilevel Mediation Study. *Journal of Educational Computing Research*, *61*(4), 817–846. https://doi.org/10.1177/07356331221137107

Zhang, W., & Gu, L. (2023). The role of computer game playing and reading attitudes in digital reading achievement: evidence from Hong Kong 15-year-olds. *Research and Practice in Technology Enhanced Learning*, *18*, 019. https://doi.org/10.58459/rptel.2023.18019

8. List of tables and figures

8.1. List of tables

8.2. List of figures