



University  
of Glasgow

Adam Smith  
Business School

# WORKING PAPER SERIES



Is Literacy a Multi-dimensional Concept? Some  
Empirical Evidence

Georgios A. Panos, Theocharis Kromydas, Michael Osborne  
and Robert E. Wright

Paper no. 2020-27  
October 2020

## Is Literacy a Multi-dimensional Concept? Some Empirical Evidence

by

Georgios A. Panos<sup>1</sup>  
Theocharis Kromydas  
Michael Osborne  
Robert E. Wright

University of Glasgow

October 30, 2020

**Abstract:** Literacy is a multi-dimensional concept. In this chapter, seven potential dimensions of literacy are considered: (1) *Mathematical literacy*, (2) *Foreign language literacy*, (3) *Digital literacy*, (4) *Financial literacy*, (5) *Political literacy*, (6) *Environmental literacy*, and (7) *Health literacy*. Data from the Glasgow-based *Integrated Multimedia City Data (iMCD)* project included information that allows for the operationalization of these dimensions. Multiple-regression analysis is used to explore the correlates of these dimensions of literacy. One key finding is that there are gender differences in all the dimensions of literacy. There are large advantages in favour of males with respect to political, digital, financial, and environmental literacy, health and mathematical literacy. The only advantage in the favour of females is foreign language literacy.

**Acknowledgement:** Funding from the *PROFIT* project is gratefully acknowledged. *PROFIT* has received funding from the *European Union's Horizon 2020 Framework Programme for Research and Innovation* under grant agreement no. 687895. We thank the Urban Big Data Centre at the University of Glasgow for sharing the iMCD data. The work was supported by the Economic and Social Research Council (grant numbers ES/L011921/1, ES/S007105/1). We are grateful to Konstantinos Gkrimmotsis and Christoforos Bouzanis for research assistance and helpful comments, and Catherine Lido for insights and comments on the iMCD data. The original collectors of the data, the Urban Big Data Centre and the affiliated institutions bear no responsibility for the analysis or interpretations presented in this chapter.

<sup>1</sup> Corresponding author: Professor Georgios A. Panos, Adam Smith Business School, University of Glasgow, Room 545A Gilbert Scott Building, University Avenue, Glasgow G12 8QQ, United Kingdom. Georgios.Panos@glasgow.ac.uk, +44 141 330 5317

## 1. Introduction

The concept of “literacy” traditionally focuses on the “so-called three Rs” taught in school: *Reading, Writing and Arithmetic*. However, more modern concepts have moved beyond basic language understanding and mathematical skills. For example, UNESCO (2003: 3) defines literacy as “*the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts*”. The Programme for International Student Assessment (PISA) views literacy as a combination of reading, writing, mathematics, science and problem-solving (OECD, 2003). The definition of literacy by the Programme for the International Assessment of Adult Competencies (PIAAC) is the “*understanding, evaluating, using and engaging with written texts to participate in society, to achieve one’s goals, and to develop one’s knowledge and potential*” (OECD, 2009: 8). It is the skill set needed to “*facilitate the creation of personal, social and economic well-being*” (OECD, 2009: 5). Likewise, the European Commission (2012) widened its definition to include numeracy, digital and social competences. There are even broader definitions. For example, Barton (2007) views literacy as a “*social practice*” that provides the skills and experiences needed for full participation in society.

It is clear that a more meaningful definition of literacy consists of several dimensions. However, there is little agreement of what these dimensions should be. There is even less agreement about their relative importance. It is our view that much can be learned in both respects from the empirical operationalization and subsequent statistical analysis of these potential dimensions. Such an approach is very demanding in terms of both the quantity and quality of the data needed. One approach is to use survey data, where respondents are asked questions aimed at capturing these different dimensions of literacy. We are aware of only one survey, described in detail below, that includes enough questions of this type to make such an

analysis feasible—the Glasgow-based *Integrated Multimedia City Data (iMCD)* project. In this survey, at the recommendations of the authors of this chapter, questions aimed at capturing seven possible dimensions of literacy were included: (1) *Mathematical literacy*, (2) *Foreign language literacy*, (3) *Digital literacy*, (4) *Financial literacy*, (5) *Political literacy*, (6) *Environmental literacy*, and (7) *Health literacy*.

The purpose of this chapter is primarily to examine the factors that might help explain the above dimensions of literacy. It is not our aim to argue that these dimensions are in some way the important ones. There are other potentially important dimensions of literacy, such a “geo-literacy”, that the *iMCD* project includes no information about (Nolan, 2002). Our analysis is concerned with the statistical relationships between these different dimensions of literacy. It is also concerned with the similarities and differences in the statistical correlations these dimensions exhibit with potential explanatory factors. The analysis is descriptive and we do not argue that these relationships are causal. This said, we are not aware of any previous studies that have examined statistically, in a systematic manner, seven possible dimensions of literacy in a single study. In this sense, we believe that our analysis is both new and novel, with some new knowledge being created. At the very least, we hope our analysis suggests possible directions for meaningful future research both in terms of data collection and statistical analysis.

With this brief introduction in mind, the remainder of this chapter is as follows. Section 2 describes the *iMCD* data used in the empirical analysis. Section 3 is a discussion of the seven dimensions of literacy that we consider. The empirical analysis, which is based in multiple regression, is outlined in Section 4. The results of the analysis are summarized in Section 4. A brief conclusion follows in Section 5.

## 2. Data: The Integrated Multimedia City Data (iMCD)

The data used in this chapter is from the integrated Multimedia City Data (iMCD) project, collected by the *Urban Big Data Centre* at the *University of Glasgow* (Lido, *et al.*, 2019; 2020; Thakuriah, *et al.*, 2020). The iMCD micro-dataset comprises of a 1,501-household survey of the Greater Glasgow area measuring attitudes and behaviors with respect to education, transportation, digital engagement, sustainability, cultural and civic activities, as well as a host of household demographics from work to housing. The data collection took place during late 2015. The data is representative of the population of Greater Glasgow, and the data collectors have provided customized household and population weights to be used in analysis aiming for population estimates.

The estimated population of the Greater Glasgow area is 1.2 million. Including the region surrounding the conurbation, the population goes up to 2.8 million, representing approximately 42% of the population of Scotland (National Records of Scotland, 2020). The region is characterized by vast challenges in the domains of social inequality, crime, health, and relative deprivation, compared to the rest of the United Kingdom. Moreover, according to the BBC (2013), Glasgow was the least peaceful urban area in the United Kingdom. The World Health Organisation (2011) also recognizes Glasgow as a region of large health inequalities with life expectancies within the city differencing by as much as 28 years, depending on the area of birth. Hence, the Greater Glasgow region is a particularly interesting setting to examine inequities in dimensions of literacy. One of strengths of the iMCD project is that it provides a secure geo-coded dataset, which merges household zip-codes with government data on the Scottish Index of Multiple Deprivation (hereafter SIMD) 2016. The SIMD is a tool for identifying the places in Scotland where people are experiencing disadvantage across different aspects of their lives.

Table 1 reports the mean values for the variables used in our analysis. The estimates are weighted to reflect population totals. As is the case in most large-scale sample surveys, the iMCD surveys includes a set of sample or survey weights. The weights are used to adjust the sample estimates to better reflect population values. Analysis suggests that the *iMCD* data is representative of the population of the Glasgow in the period that the data refer to (Thakuria, *et al.*, 2020)

*[Insert Table 1 about here]*

### **3. Dimensions of Literacy: Measurement**

#### **3.1 Mathematical Literacy**

The first dimension of literacy that we consider is “Mathematical literacy” According to Kolata (1997: 28), quantitative literacy means knowing how to reason and how to think, and “*it is all but absent from our curricula today*”. The National Council on Education and the Disciplines (NCED, 2003: vii) in the USA tells us that “*Numbers, of course, have long been important in the management of life, but they have never been so ubiquitous as they are now*”. In our setting, the mathematical literacy question was a fairly standard quantitative literacy question about applying maths in daily life, i.e. “*How confident would you say you are in using maths in everyday life, for instance, figuring out how much change is owed, or how much you have saved on a discounted item?*” The response options are: (0) Not at all confident; (1) Not very confident; (2) Quite confident; and (3) Very confident.

#### **3.2 Foreign Language Literacy**

The second dimension of literacy is “Foreign language literacy”. The European Commission (2008) adopted a Council Resolution on a European strategy for multilingualism (2008/C

320/01), which addresses languages in the wider context of social cohesion and prosperity and focuses on actions to encourage and assist citizens in acquiring language skills. Foreign language literacy is measured by the following question: “*(Apart from English) Do you speak any other language at least well enough to hold a conversation?*”. The response options were: (i) French; (ii) German; (iii) Italian; and (iv) Other. We aggregate responses across the four options in an index, which ranges from 0 to 3, corresponding to the number of languages by the respondent.

### **3.3 Digital Literacy**

The third dimension of literacy is “Digital literacy”. The importance of digital competence was recognised by the European Commission (2006; 2014) in its recommendation on key competences for lifelong learning when it identified digital competence as one of eight key competences essential for all individuals in a knowledge-based society. The American Library Association (2016) offers this definition: “*Digital literacy is the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills*”. In our study, the primary digital literacy proxy examines two domains of knowledge, namely problem-solving and confidence carrying out creative activities online. The first question asked: “*When something goes wrong with your computer, like connecting to a network or getting a new device to work, how confident are you that you could fix the problem yourself rather than get someone else to fix it for you?*” The second question asked: “*How confident are you in your skills to do creating things online, like making online profiles, sharing photos or uploading short videos?*” The response options in both questions were: (0) Not at all confident; (1) Not very confident; (2) Fairly confident; and (3) Very confident. We aggregate the responses in the two questions into an index ranging from 0 to 6.

### 3.4 Financial Literacy

The fourth dimension of literacy is “Financial literacy”. According to the website of USA’s National Financial Educators Council (2019), financial literacy can be defined as the possession of “*the skills and knowledge on financial matters to confidently take effective action that best fulfills an individual’s personal, family and global community goals*”. It is more than numeracy, i.e. being good with numbers, although numeracy is important in its own right (Panos and Wright, 2020). It includes for example the understanding of compound interest rates, nominal and real interest rates and financial risk diversification. Individuals who are more financial literate have been shown to make more economically rational decisions throughout the lifecycle, e.g. pertaining to real estate purchases, insurance purchases, investing, saving, tax planning, retirement planning and pension planning, *inter alia*.

Our financial literacy measure uses the standard three multiple-choice questions developed by Lusardi and Mitchell (2014) to evaluate the level of financial knowledge of respondent, capturing the understanding of interest rates, especially compounding, the understanding of inflation, and the understanding of risk diversification. The first question asked: “*Suppose you had £100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow. Would it be...*”. The response options were the following: (i) *More than £102*; (ii) *Exactly £102*; (iii) *Less than £102*; (iv) *Don’t know*; (v) *Refuse to answer*. The second question asked: “*Imagine that the interest rate on your savings account was 1% per year and that inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? (assuming that you buy exactly the same basket of goods in both years)...*”. The response options were: (i) *More than today*; (ii) *Exactly the same*; (iii) *Less than today*; (iv) *Don’t know*; (v) *Refuse to answer*. The third question asked: “*Which is the riskier asset to invest in?*”. The



response options were: (i) *A single company's share*; (ii) *A portfolio of different company shares*; (iii) *The risk is the same*; (iv) *Don't know* (v) *Refuse to answer*. We aggregate the number of correct responses at an index ranging from 0 to 3.

### **3.5 Political Literacy**

The fifth dimension of literacy is “Political literacy”. Political literacy can be thought of as comprising of a set of skills and abilities considered necessary for citizens to participate actively in society (Kus, 2015) and a society's government. It includes an understanding of how government works and of the important issues facing society, as well as the critical thinking skills to evaluate different points of view. Westholm, *et al.* (1990: 170) define political literacy as “*the basic concepts and facts that constitute a necessary condition for comprehending the contents of public debate*”. Denver and Hands (1990: 263) define political literacy as “*the knowledge and understanding of the political process and political issues which enables people to perform their roles as citizens effectively*”. Cassel and Lo (1997: 321) define political literacy as being “*knowledgeable of basic political concepts and facts*”. For the purposes of the iMCD project, our primary proxy for political literacy is captured via self-reported political knowledge, measured by the following question: “*How much, if anything, do you feel you know about politics*. The responses are: (0) Nothing at all (1) Not very much (2) A fair amount and (3) A great deal”

### **3.6 Environmental Literacy**

The sixth dimension of literacy is “Environmental literacy”. The most widely accepted definition of environmental literacy is that it comprises an awareness of and concern about the environment and its associated problems, as well as the knowledge, skills, and motivations to work toward solutions of current problems and the prevention of new ones (NAAEE, 2000;

2011). McBride, *et al.* (2013) elaborate on the distinction in the terminology between environmental literacy, ecological literacy, and eco-literacy. For instance, ecological literacy can be perceived to be founded upon knowledge and understanding about how the ecological systems of the Earth function and support life. There is a widespread concern that levels of ecological literacy within many contemporary human communities are inadequate to enable effective decision-making about sustainable ways of living. For the purposes of this study, we utilize the terms environmental literacy and ecological literacy interchangeably.

We utilize one specific question from the iMCD questionnaire to derive our primary proxy for environmental literacy via self-reported eco-knowledge measured by the following items on a 5-point Likert scale. “*How much, if anything, would you say you know about the following? (i) Climate change; (ii) Carbon footprint; (iii) Biodiversity*”. The response categories were the following: (0) Have never heard of it; (1) Have heard of it but know nothing about it; (2) Just a little; (3) A fair amount; (4) A lot. We derive the summation of responses in the three components of the question to deduct an index for environmental literacy ranging from 0 to 12.

### **3.7 Health Literacy**

The seventh and final dimension of literacy is “Health literacy”. It can be defined as the ability to obtain, read, understand, and use healthcare information in order to make appropriate health decisions and follow instructions for treatment (Institute of Medicine, 2004). Early US evidence showed that 36% of participants scored as either “basic” or “below basic” in terms of their health literacy and concluded that approximately 80 million Americans have limited health literacy (Kutner, et al., 2006). Consequently, health illiterate individuals have difficulty with common health tasks including reading the label of a prescribed drug. Key contributing factors to health illiteracy were old age, limited English language proficiency, low education

and lower socioeconomic status (American Medical Association, 1999). Nutbeam (2000) suggests that increasing health literacy and embedding it within public education and communication can better empower individuals to overcome the ‘structural barriers’ to positive health and well-being.

Our empirical proxy for health literacy in the iMCD survey is derived from the following question: “*How often do you generally take part in physical exercise (e.g. sport, walking, swimming)?*” The response categories were the following: (0) At least once a week; (1) At least once a month; (2) At least once a year but not regularly; (3) Less than once a year; (4) Never. We utilize the linear version of the variable for health literacy, after ensuring that the results are robust when using the ordinal version.

#### **4. Empirical Analysis**

In this section, we analyse the above dimensions of literacy through the application of multiple regression. In these regressions, a specific dimension of literacy (e.g. mathematical literacy) is related to set of variables thought to be potential explanatory factors. These factors are:

*Gender* = Dummy variable for Male

*Education* = Years of schooling completed

*Age* = Dummy variables for different age groups

*Marital status* = Dummy variables for “Single”, “Widowed/divorced/separated” and “Married/cohabiting”

*Children* = Logarithm of (number of children plus one)

*Migration status* = Dummy variables for “Scotland-born”, “Rest of UK-born” and “Foreign-born”

*Ethnicity* = Dummy variable for “white” ethnic group

*Religion* = Dummy variables for “Christian”, “Atheist”, “Islamic” and “Other”

*Health status* = Dummy variables for “Very bad” to “Very good” self-assessed health

*Social capital* = Frequency of talking to neighbors, ranging between 1 and 5+

*Home owner* = Dummy variable for owing one's home

*Income and Income<sup>2</sup>* = Net annual individual income in Pounds Sterling divided by 10,000 and its square

*Labour market status* = Dummy variables for "Entrepreneur", "Self-employed", "Full-time employee", "Part-time employee", "Home-carer", "Retired", "Unemployed", "Student" and "Inactive"

*Current/last occupation class* (Dummy variables for "Modern Professional", "Clerical and intermediate", "Senior managers and administrators", "Technical and craft", "Semi-routine manual and service", "Routine manual and service", "Middle or junior managers", "Traditional professional occupations" and "Other occupations")

*Deprivation, Scottish Index of Multiple Deprivations (SIMD)* Dummy variables based on household's post-code, Bottom 20% (most deprived), ..., Top 20% (least deprived)

*Council area* = Dummy variables for "East Renfrewshire", "Glasgow City", "Inverclyde", "North Lanarkshire", "Renfrewshire", "South Lanarkshire" and "West Dunbartonshire"

The regression estimates are summarized in Table 2. The estimates for mathematical literacy are presented in column (1), the estimates for foreign language literacy in column (2), for digital literacy in column (3), for financial literacy in column (4), for political literacy in column (5), for environmental literacy in column (6), and for health literacy in column (7).

*[Insert Table 2 about here]*

The estimates in column (1) reveal a gender difference in mathematical literacy in favor of men. The magnitude of the gender effect, obtained via dividing the coefficient with the linear prediction of the model, is 6.75%. Then, an additional year of schooling increases mathematical literacy by some 2.9%. Younger groups appear more mathematically literate, especially those aged 16-24. After the age of 45 mathematical literacy declines. Estimations for those aged above 75 are the lowest among all age groups in consistency with the literature on cognitive decline among the elderly. There are positive effects on mathematical literacy from the social

capital proxy (i.e. how often they meet neighbours), and from the 4<sup>th</sup> SIMD centile (less deprived). Household heads, students, the retired and entrepreneurs, as well as those in managerial and professional occupations appear to be more mathematically literate.

In column (2), males are much less literate in foreign languages, with the magnitude of the effect being in the order of -22.62%. An additional year of schooling exerts an effect of the opposite sign but of similar magnitude to that of gender. Those aged 45-59 appear to be more foreign language literate, while there are no significant differences for the remaining age groups. Individual income exerts a non-linear positive effect on foreign language literacy and higher SIMD centile groups (i.e. those residing in less deprived areas) are more foreign-language literate, compared to those residing in more deprived areas. Evidently, migrants are more foreign language literate. So are those in professional occupations.

In terms of digital literacy, in column (3), males are shown to be more literate, with the magnitude of the effect being of 16.35%. An additional year of schooling increases digital literacy by 5.63%. Younger individuals are more digitally literate, with the group aged 16-24 ranking the highest while the widowed/divorced/separated group ranks the lowest. The widowed/divorced separated group appears less digitally literate. Those with better health, employees and the self-employed, and students are among the most digitally literate groups. Managers and professionals, and those in clerical and intermediate occupations are among the most digitally literate groups.

Consistently with the literature from western countries, males are more financially literate, with the magnitude of the effect being 13.7%. An additional year of schooling increases financial literacy by 4.4%. However, there are no major age differences in financial literacy. The cohabiting/married group, homeowners, those with higher income and in 3<sup>rd</sup> and 4<sup>th</sup> SIMD centiles are more financially literate, compared to those residing in the most deprived areas.

Those with better health and students appear to be among the most financially literate groups in the sample.

Column (5) presents estimates of the determinants of political literacy. Males are more politically literate, with the magnitude of the effect being of 24.6%. An additional year of schooling increases political literacy by 3.9%. The older groups are more politically literate, with the group aged between 60-74 ranking the highest. Individuals residing in areas of the 5<sup>th</sup> SIMD centile are the most politically literate, compared to individuals living in more deprived areas. Students, the retired and entrepreneurs appear to be the most politically literate occupation groups. So are those in professional and managerial occupations.

In column (6) we present estimates of the determinants of environmental literacy. Once again, it appears males are more environmentally literate by some 12.7%. An additional year of schooling increases environmental literacy by some 5.7%. The group aged 35-44 is the most environmentally literate age group. Homeowners, and individuals residing in less deprived areas appear to be more environmentally literate. Individuals born in Scotland appear less environmentally literate, compared to those born in the rest of the UK and the migrants. The unemployed and the inactive appear to be more environmentally literate, and so do those in professional and managerial occupations.

Finally, we present the estimates of the determinants of health literacy in column (7). Males are more health literate by some 7.5%. Younger groups appear more health literate, with groups aged 25-34 and 35-44 ranking the highest in terms of health literacy. Household heads, the cohabiting/married individuals, and the self-employed appear less health literate and individuals with higher social capital are more health literate. Evidently, those in better health are more health literate, and so are the individuals in professional occupations. Health literacy appears to be related to multiple deprivation of the area of residence, with individuals residing

in more deprived areas being less health literate. Health literacy appears to increase progressively at less deprived SIMD.

## **5. Conclusion**

One of the main findings of the empirical analysis is that there are gender differences in all the dimension of literacy that we consider, with females outperforming males only in terms of foreign language literacy. There are notable differences in favour of men with respect to political, digital, financial, and environmental literacy, and smaller differences in favour of men with respect to health and mathematical literacy. The raw gender gaps, in percentage terms, between males and females is females score 0.153 less in mathematical literacy, 0.052 more in foreign language literacy, 0.464 less in digital literacy, 0.254 less in financial literacy, 0.359 less in political literacy, 0.730 less in environmental literacy, and 0.199 less in terms of health literacy. After adjusting the raw gaps using the linear prediction from the regression estimates, the gaps are still sizeable. More specifically, females score 6.8% less in mathematical literacy, 22.6% more in foreign language literacy, 16.4% less in digital literacy, 13.7% less in financial literacy, 24.6% less in political literacy, 12.7% less in environmental literacy, and 7.8% less in terms of health literacy. We believe that understanding the differences behind these gender gaps in literacy should be a research priority

It is worth highlighting that students in our sample appear to be among the most literate groups, with the sole exceptions of foreign language literacy. Although this observation is important in view of the need for cultural agility in robot-proof education (Aoun, 2017), most important inferences can be made for the necessity to re-conceptualize the priorities of adult literacy programs. Older groups appear more challenged in terms of digital literacy and health literacy. Moreover, gender differences are prevalent in older groups for most of the dimensions

of literacy that we consider. Thus, the design of training programs, suitable for gender-neutral adult education and the generation of opportunities for ‘*robot-proof*’ lifelong learning, as well as targeted interventions for challenged and vulnerable groups are of utmost importance in this new era.

We know from successive UNESCO Global Reports on Adult and Lifelong Learning (GRALE) of the benefits of adult and lifelong learning (ALE) to health and well-being (SDG4), and civic responsibility with potential concomitant effects on climate change (SDG13) and responsible consumption (SDG12) (e.g. UNESCO-UIL, 2017). Literacy targets in SDG 4, however, largely focus on functional matters with target 4.6 stating that ‘*all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy*’, though indicator 4.4.1 focuses on digital skills and target 4.7 skills to support environmental sustainability. There is a need for a broadened conception of what constitute fundamental literacies, and for this to be reflected in educational offers.

## References

- American Medical Association (1999). “Health Literacy: Report of the Council on Scientific Affairs. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, American Medical Association”. *Journal of the American Medical Association (JAMA)*. 281 (6): 552–557.
- American Library Association (2016). “Digital Literacy”. 2<sup>nd</sup> Aug. 2016. Available at: <http://www.ala.org/pla/initiatives/digitalliteracy>
- Aoun, J. E. (2017). *Robot-Proof: Higher Education in the Age of Artificial Intelligence*. Boston, MA: The MIT Press.
- Barton, D. (2007). *Literacy: An Introduction to the ecology of written language*. 2nd ed. Oxford: Blackwell
- BBC (2013). “Glasgow Ranked UK's Most Violent Area”. 24<sup>th</sup> April 2013. Available at: <https://www.bbc.co.uk/news/uk-scotland-glasgow-west-22276018>



- Cassel, C. A. and C. C. Lo (1997). "Theories of Political Literacy". *Political Behavior*. 19: 317–335.
- Denver, D., and Hands, G. (1990). Does studying politics make a difference? The political knowledge, attitudes and perceptions of school students. *British Journal of Political Science*, 20(2): 263-279.
- European Commission (2006). "Council Recommendation on Key Competences for Lifelong Learning". Report available at: [https://ec.europa.eu/education/education-in-the-eu/council-recommendation-on-key-competences-for-lifelong-learning\\_en](https://ec.europa.eu/education/education-in-the-eu/council-recommendation-on-key-competences-for-lifelong-learning_en)
- European Commission (2008). "Multilingualism: An Asset for Europe and a Shared Commitment". Communication from the Commission to the European Parliament, the Council, The European and Social Committee and the Committee of the Regions. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52008DC0566&from=EN>
- European Commission (2012). "EU High Level Group of Experts on Literacy". Directorate-General for Education, Youth, Sport and Culture. Available at: <https://op.europa.eu/en/publication-detail/-/publication/96d782cc-7cad-4389-869a-bbc8e15e5aeb>
- European Commission (2014). "Measuring Digital Skills across the EU: EU wide indicators of Digital Competence". Report available at: <http://ec.europa.eu/digital-agenda/en/news/measuring-digital-skills-across-eu-eu-wide-indicators-digital-competence>
- Kolata, G. (1997). "Understanding the News". In Ichilov, L.A. (Ed.) *Why Numbers Count: Quantitative Literacy for Tomorrow's America*. New York, NY: The College Board, 23-29.
- Kus, Z., (2015). "Political Literacy Status of Pre-Service Social Studies Teacher". *Procedia - Social and Behavioral Sciences*. 177: 197–202.
- Kutner, M., Greenburg, E., Jin, Y., & Paulsen, C. (2006). "The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy". NCES 2006-483. *National Center for Education Statistics*.
- Lido, C., Reid, K., and M. Osborne (2019). "Lifewide Learning in the City: Novel Big Data Approaches to Exploring Learning with Large-Scale Surveys, GPS, and Social Media". *Oxford Review of Education*. 45(2): 279-295.
- Lido, C., Mason, P., Hong, J., Gorash, N., Anejionu, O. C. D., and M. Osborne (2020). "Integrated Multimedia City Data: Exploring Learning Engagement and Green Space in Glasgow". *Built Environment*. Forthcoming.
- Lusardi A., and O. S. Mitchell (2014). "The Economic Importance of Financial Literacy: Theory and Evidence". *Journal of Economic Literature*. 52(1): 5-44.
- National Council of Education and the Disciplines (NCED) (2003). *Quantitative Literacy: Why Numeracy Matters for Schools and Colleges*. Woodrow Wilson Natl Foundation. Available at: <https://www.maa.org/sites/default/files/pdf/QL/WhyNumeracyMatters.pdf>
- National Financial Educators Council (2019). "What is Financial Literacy?" Available at: <https://www.financialeducatorsCouncil.org/financial-literacy-definition/>
- National Records of Scotland (2020). Population Projections for Scottish Areas (2018-based). Edinburgh: National Records of Scotland. Report available at:

<https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-projections/sub-national-population-projections/2018-based>

- Nolan, R. E. (2002). “Geo-Literacy: How Well Adults Understand the World in Which They Live”. *Adult Education*. 12(2): 134–144
- North American Association for Environmental Education (NAAEE) (2000). *Excellence in Environmental Education: Guidelines for Learning (K–12)*. North American Association for Environmental Education. Washington, D.C., USA.
- North American Association for Environmental Education (NAAEE) (2011). *Developing a Framework for Assessing Environmental Literacy*. National Press Club: Washington, DC. Report available at: <https://naaee.org/our-work/programs/environmental-literacy-framework>
- Nutbeam, D. (2000). “Health Literacy as a Public Health Goal: A Challenge for Contemporary Health Education and Communication Strategies into the 21<sup>st</sup> Century”. *Health Promotion International*. 15(3): 259–267.
- OECD (2003). “Programme for International Student Assessment: The PISA 2003 Assessment Framework”. Paris: Organisation for Economic Co-Operation and Development. Report available at: <http://www.oecd.org/education/school/programmeforinternationalstudentassessmentpisa/33694881.pdf>
- OECD (2009). “PIAAC Literacy: A Conceptual Framework”. PIAAC Literacy Expert Group OECD Education Working Papers No. 34.
- Panos, G. A. and R. E. Wright (2020). “The Origins of Financial Literacy”. University of Glasgow Mimeo.
- Thakuria, P. (V.), Sila-Nowicka, K., Hong, J., Boididou, C., Osborne, M., Lido, C. and A. McHugh (2020). “Integrated Multimedia City Data (iMCD): A Composite Survey and Sensing Approach to Understanding Urban Living and Mobility”. *Computers, Environment and Urban Systems*. 80(101427): 1-15.
- UNESCO (2003). *Conference Report of the Information Literacy Meeting of Experts Prague*. September 20-23, 2003. Available online at: [http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/themes/info\\_lit\\_meeting\\_prague\\_2003.pdf](http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/themes/info_lit_meeting_prague_2003.pdf)
- UNESCO-UIL (2017) *Learning Cities and the SDGs: A Guide to Action*. Hamburg: UIL.
- Westholm, A., Lindquist, A. and R. G. Niemi (1990). “Education and the Making of the Informed Citizen: Political Literacy and the Outside World”. In Ichilov, O. (Ed.) *Political Socialization, Citizenship Education, and Democracy*. New York, NY: Teachers' College.
- World Health Organisation (2011). “Behind the “Glasgow effect””. *Bulletin of the World Health Organisation: Special Theme: Social Determinants of Health*. 89(10): 701–776.

**Table 1**  
**Descriptive Statistics of Regression Variables**

<b>Panel A: Weighted averages</b>							
Mathematical literacy	2.27	-" : Student	8.0%				
Foreign language literacy	0.23	-" : Inactive	6.7%				
Digital literacy	2.83	SIMD centile 1 (most deprived)	32.5%				
Financial literacy	1.85	-" : centile 2	19.5%				
Political literacy	1.46	-" : centile 3	15.1%				
Environmental literacy	5.75	-" : centile 4	15.6%				
Health literacy	2.66	-" : centile 5 (least deprived)	17.3%				
Age	46.54	Household head	71.2%				
Marital status: Single	39.9%	Born in the UK	85.6%				
-" : Widowed/Divorced/Separated	18.0%	Freq. talk to neighbours: Never	5.5%				
-" : Cohabiting/Married	42.1%	-" : Less often than once a month	6.1%				
Number of children	0.42	-" : Once or twice a month	13.5%				
Migrant	8.5%	-" : Once or twice a week	39.9%				
Ethnicity: White	95.0%	-" : Most days	35.1%				
Born in Scotland	79.0%	Health condition: Very Bad	1.9%				
Years of schooling	10.31	-" : Bad	5.8%				
Education: 'O' Grade or equiv.	13.7%	-" : Fair	13.6%				
-" : 'H' grade/A level or equiv.	22.5%	-" : Good	34.1%				
-" : HNC/HND or equiv.	11.2%	-" : Very good	44.6%				
-" : Degree or professional qual. or higher	27.8%	Last occupation: Modern professional	14.8%				
-" : None of these	22.2%	-" : Clerical and intermediate	12.8%				
-" : Other	2.55%	-" : Senior managers or administrators	6.4%				
Home owner	58.9%	-" : Technical and craft	8.9%				
Total Net Annual Individual Income	14,201.8	-" : Semi-routine manual and service	10.9%				
Religion: Christian	40.5%	-" : Routine manual and service	12.1%				
-" : Atheist	55.5%	-" : Middle or junior managers	4.6%				
-" : Islamic	2.2%	-" : Traditional professional	3.7%				
		occupations					
-" : Other	1.9%	-" : Other	25.9%				
Social capital	3.93	Local authority: East Dunbartonshire	6.0%				
Disabled	25.60%	-" : East Renfrewshire	4.7%				
Labour market status: Entrepreneur	4.3%	-" : Glasgow City	33.9%				
-" : Self employed	1.1%	-" : Inverclyde	4.5%				
-" : Full-time employee	36.0%	-" : North Lanarkshire	18.6%				
-" : Part-time employee	8.9%	-" : Renfrewshire	9.8%				
-" : Homecarer	4.9%	-" : South Lanarkshire	17.6%				
-" : Retired	22.9%	-" : West Dunbartonshire	5.0%				
-" : Unemployed	7.2%						
<b>Panel B: Weighted correlation matrix</b>							
	Mathematical literacy	Foreign language literacy	Digital literacy	Financial literacy	Political literacy	Environmental literacy	Health literacy
Mathematical literacy	1.00						
Foreign language literacy	0.10*	1.00					
Digital literacy	0.23*	0.11*	1.00				
Financial literacy	0.21*	0.04	0.18*	1.00			
Political literacy	0.25*	0.07*	0.14*	0.20*	1.00		
Environmental literacy	0.34*	0.18*	0.30*	0.28*	0.51*	1.00	
Health literacy	0.20*	0.06*	0.20*	0.14*	0.10*	0.13*	1.00

Notes: N = 2,905. Estimates are weighted to reflect population totals. In panel B, asterisks denote the 5% level of significance

**Table 2**  
Regression Estimates of the Correlates of Literacy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	<i>Mathematical</i>	<i>Foreign language</i>	<i>Digital</i>	<i>Financial</i>	<i>Political</i>	<i>Environmental</i>	<i>Health</i>
<b>I) Calculated effects:</b>							
<i>Linear prediction</i>	2.2655	0.2294	2.8349	1.8514	1.4606	5.7471	2.6589
<i>%Gender effect</i>	6.75%	-22.62%	16.35%	13.74%	24.60%	12.70%	7.47%
<b>II) Model estimates:</b>							
Male	0.153*** [0.042]	-0.052** [0.024]	0.464*** [0.090]	0.254*** [0.049]	0.359*** [0.041]	0.730*** [0.117]	0.199*** [0.066]
Years of schooling	0.065*** [0.019]	0.056*** [0.010]	0.151*** [0.037]	0.081*** [0.022]	0.057*** [0.020]	0.329*** [0.065]	0.014 [0.026]
Age group 1: 16-24	0.263** [0.128]	0.102 [0.077]	3.473*** [0.298]	0.133 [0.165]	-0.062 [0.137]	0.404 [0.418]	0.726*** [0.231]
-" 2: 25-34	0.229* [0.117]	0.025 [0.070]	2.558*** [0.276]	0.168 [0.144]	0.065 [0.115]	0.967*** [0.373]	0.887*** [0.211]
-" 3: 35-44	0.201* [0.116]	0.089 [0.072]	1.872*** [0.266]	0.23 [0.140]	0.037 [0.113]	1.139*** [0.363]	0.865*** [0.213]
-" 4: 45-59	0.143 [0.097]	0.119* [0.066]	1.327*** [0.234]	0.188 [0.123]	0.119 [0.094]	1.019*** [0.323]	0.564*** [0.188]
-" 5: 60-74	0.121* [0.067]	0.031 [0.038]	0.692*** [0.123]	0.153* [0.086]	0.159** [0.065]	1.035*** [0.202]	0.562*** [0.138]
-" 6: ≥75	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
Household head	0.091** [0.045]	-0.075*** [0.026]	0.069 [0.105]	-0.099* [0.056]	0.024 [0.047]	0.219 [0.136]	-0.295*** [0.070]
Ethnicity: White	0.006 [0.112]	-0.112 [0.077]	0.258 [0.246]	0.325** [0.130]	0.083 [0.115]	0.214 [0.357]	0.051 [0.169]
Migrant	0.067 [0.093]	0.563*** [0.064]	-0.221 [0.179]	0.004 [0.120]	-0.306*** [0.095]	-0.087 [0.302]	0.075 [0.139]
Born in Scotland	0.086 [0.058]	-0.088** [0.036]	-0.125 [0.121]	0.032 [0.066]	-0.065 [0.062]	-0.336* [0.185]	0.096 [0.101]
Born in rest of UK	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
Marital status: Single	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : Widowed/Divorced/ Separated	0.019 [0.070]	0.041 [0.033]	-0.288* [0.153]	0.071 [0.084]	0.016 [0.065]	0.048 [0.192]	0.157 [0.117]
-" : Cohabiting/Married	0.034 [0.060]	0.021 [0.028]	-0.195 [0.136]	0.159** [0.067]	0.045 [0.058]	0.037 [0.165]	-0.237** [0.094]
Log(Number of children)	0.059 [0.055]	0.005 [0.030]	0.191* [0.111]	0.003 [0.071]	0.069 [0.060]	0.105 [0.162]	-0.099 [0.081]
Religion: Christian	-0.072* [0.042]	-0.034 [0.023]	0.171* [0.091]	-0.037 [0.049]	0.002 [0.042]	0.242* [0.124]	-0.044 [0.068]
-" : Atheist	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : Islamic	-0.039 [0.172]	0.259** [0.124]	-0.085 [0.313]	-0.211 [0.256]	-0.042 [0.173]	-0.160 [0.597]	-0.314 [0.212]
-" : Other	0.202 [0.144]	0.127* [0.076]	0.757* [0.402]	0.263* [0.159]	0.135 [0.173]	0.433 [0.525]	-0.023 [0.242]
Social capital	0.060*** [0.021]	0.003 [0.010]	0.066 [0.042]	0.026 [0.023]	0.028 [0.021]	0.011 [0.056]	0.072** [0.031]
Health condition: Very bad	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : Bad	0.524** [0.237]	0.025 [0.048]	0.143 [0.278]	0.341 [0.216]	-0.028 [0.173]	-0.315 [0.490]	0.565** [0.251]

*Table 2 continued in next page*

Table 2 continued from last page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
-" : Fair	0.690*** [0.226]	0.092* [0.049]	0.418 [0.269]	0.472** [0.211]	-0.007 [0.172]	-0.361 [0.470]	1.355*** [0.243]
-" : Good	0.739*** [0.222]	0.090* [0.051]	0.574** [0.268]	0.528*** [0.204]	0.031 [0.169]	0.055 [0.474]	1.723*** [0.232]
-" : Very good	0.810*** [0.223]	0.080 [0.054]	0.862*** [0.274]	0.511** [0.204]	0.023 [0.172]	0.083 [0.482]	1.840*** [0.231]
Labour market status: Entrepreneur	0.281* [0.146]	-0.056 [0.074]	0.775** [0.322]	0.171 [0.175]	0.238* [0.130]	0.760* [0.405]	-0.313 [0.217]
-" : Self employed	0.247 [0.176]	0.021 [0.104]	0.773 [0.480]	0.140 [0.262]	0.214 [0.176]	1.233* [0.674]	-0.732** [0.366]
-" : Full-time employee	0.126 [0.135]	-0.079 [0.059]	0.847*** [0.265]	-0.004 [0.143]	0.144 [0.112]	0.574 [0.356]	-0.344* [0.185]
-" : Part-time employee	0.079 [0.149]	-0.049 [0.064]	0.890*** [0.287]	0.055 [0.158]	0.162 [0.122]	0.555 [0.385]	-0.145 [0.201]
-" : Homemaker	0.013 [0.152]	-0.071 [0.056]	0.116 [0.282]	0.116 [0.163]	0.188 [0.127]	0.132 [0.360]	0.045 [0.208]
-" : Retired	0.382** [0.150]	0.103 [0.076]	0.402 [0.305]	0.039 [0.156]	0.257** [0.122]	0.600 [0.413]	-0.155 [0.214]
-" : Unemployed	0.011 [0.136]	-0.099* [0.054]	0.22 [0.265]	-0.166 [0.146]	0.016 [0.118]	0.650* [0.366]	-0.175 [0.203]
-" : Student	0.404*** [0.140]	0.09 [0.081]	0.669** [0.283]	0.392** [0.178]	0.375*** [0.141]	1.751*** [0.422]	0.133 [0.210]
-" : Inactive	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
Last occupation: Modern professional	0.197*** [0.074]	0.143*** [0.043]	0.633*** [0.166]	0.339*** [0.095]	0.244*** [0.074]	1.038*** [0.241]	0.210* [0.126]
-" : Clerical & intermediate	0.087 [0.075]	0.081** [0.039]	0.402** [0.158]	0.182* [0.099]	0.085 [0.074]	0.324 [0.211]	0.076 [0.129]
-" : Senior managers or administrators	0.247*** [0.082]	0.040 [0.048]	0.701*** [0.199]	0.380*** [0.107]	0.430*** [0.084]	1.801*** [0.260]	0.155 [0.150]
-" : Technical and craft	0.115 [0.082]	0.024 [0.033]	-0.09 [0.200]	0.178* [0.105]	-0.066 [0.088]	0.322 [0.253]	-0.182 [0.144]
-" : Semi-routine manual and service	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : Routine manual and service	-0.154* [0.083]	0.015 [0.027]	-0.262 [0.171]	-0.120 [0.099]	-0.105 [0.075]	-0.481** [0.217]	-0.151 [0.132]
-" : Middle or junior managers	0.245*** [0.091]	0.054 [0.059]	0.599*** [0.217]	0.451*** [0.114]	0.206** [0.085]	1.276*** [0.262]	0.257 [0.159]
-" : Traditional professional occupations	0.285*** [0.101]	0.104 [0.068]	0.470* [0.285]	0.657*** [0.132]	0.064 [0.092]	0.915*** [0.324]	0.302* [0.176]
-" : Other	-0.020 [0.091]	0.100** [0.045]	0.236 [0.183]	-0.037 [0.109]	-0.031 [0.088]	0.158 [0.269]	-0.24 [0.146]
Home owner	0.052 [0.051]	-0.049* [0.029]	0.140 [0.102]	0.217*** [0.064]	0.049 [0.052]	0.246* [0.148]	0.087 [0.078]
Net Annual Individual Income /10,000	0.036 [0.030]	0.069*** [0.018]	-0.008 [0.066]	0.091*** [0.035]	-0.027 [0.029]	-0.009 [0.091]	0.074 [0.047]
(Net Annual Individual Income /10,000)^2	-0.001 [0.003]	-0.006*** [0.002]	0.013* [0.008]	-0.005 [0.004]	0.006** [0.003]	0.014 [0.012]	-0.004 [0.005]
SIMD centile 1 (most deprived)	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : 2	0.019 [0.063]	0.028 [0.027]	-0.036 [0.126]	0.056 [0.076]	0.013 [0.058]	0.129 [0.174]	0.350*** [0.096]
-" : 3	0.003 [0.062]	0.116*** [0.037]	-0.055 [0.135]	0.298*** [0.077]	-0.042 [0.070]	0.658*** [0.212]	0.292*** [0.108]

Table 2 continued in next page

Table 2 continued from last page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
-" : 4	0.135** [0.066]	0.117*** [0.037]	-0.13 [0.139]	0.212*** [0.077]	0.07 [0.071]	0.808*** [0.204]	0.261** [0.102]
-" : 5 (least deprived)	0.040 [0.070]	0.097** [0.048]	-0.136 [0.144]	0.093 [0.095]	0.165** [0.077]	0.911*** [0.218]	0.081 [0.108]
Council area: East Dunbartonshire	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}	{Ref.}
-" : East Renfrewshire	0.039 [0.098]	0.009 [0.085]	0.291 [0.247]	0.262* [0.154]	0.094 [0.112]	-0.482 [0.365]	0.551*** [0.191]
-" : Glasgow City	0.002 [0.075]	0.082 [0.061]	0.266 [0.199]	-0.059 [0.134]	-0.033 [0.080]	-0.291 [0.277]	0.167 [0.136]
-" : Inverclyde	0.218 [0.133]	0.114 [0.084]	0.599** [0.299]	0.666*** [0.182]	-0.215 [0.161]	-0.579 [0.445]	0.267 [0.226]
-" : North Lanarkshire	-0.180** [0.080]	-0.004 [0.059]	0.217 [0.209]	0.092 [0.138]	-0.204** [0.085]	-0.789*** [0.284]	0.16 [0.147]
-" : Renfrewshire	0.132 [0.093]	0.035 [0.063]	0.217 [0.236]	-0.034 [0.151]	-0.078 [0.103]	-0.770** [0.310]	0.617*** [0.158]
-" : South Lanarkshire	-0.04 [0.082]	0.038 [0.063]	0.16 [0.212]	0.027 [0.139]	-0.193** [0.088]	-0.629** [0.301]	0.302** [0.149]
-" : West Dunbartonshire	0.172* [0.102]	0.022 [0.071]	0.222 [0.277]	-0.016 [0.176]	0.008 [0.113]	-0.326 [0.330]	0.632*** [0.181]
Constant	-0.131 [0.352]	-0.524*** [0.172]	-2.879*** [0.656]	-0.759** [0.369]	0.254 [0.329]	-0.255 [1.054]	-0.293 [0.481]
No. of observations	2,095	2,095	2,095	2,095	2,095	2,095	2,095
No. of households	1,511	1,511	1,511	1,511	1,511	1,511	1,511
R <sup>2</sup>	0.183	0.300	0.450	0.258	0.194	0.294	0.201
F-statistic	7.83***	16.68***	56.95***	15.44***	9.06***	17.56***	9.86***

Notes:

(1) Estimates are weighted to reflect population totals.

(2) Standard errors, in brackets, are corrected are adjusted for clustering at the household level

(3) Statistical significance: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01.

(4) Calculated effects stem from dividing the coefficient with the linear prediction of the model.