

Supplement - Capital in Computing Education: Investigating Factors Underlying Participation

Thom Kunkeler Aletta Nylén
thom.kunkeler@it.uu.se aletta.nylen@it.uu.se

March 2024

1 Introduction

This document provides the supplementing material for the following publication:

[1] Thom Kunkeler and Aletta Nylén. Capital in Computing Education: Investigating Factors Underlying Participation. 2024. In *Proceedings of the 2024 Conference on Innovation and Technology in Computer Science Education* (Milan, Italy, 2024-07-08) (ITiCSE'24).

In this publication, we developed a validated survey instrument to measure capital in computing education. Capital refers to the legitimate, valuable and exchangeable resources that individuals use to generate social advantage within specific fields [2]. In computing education, a theoretical model has been developed highlighting the forms of capital which influence participation and success in the field [3]. This study assessed the theoretical model through careful survey design and Confirmatory Factor Analysis (CFA). The hypothesised survey structure was assessed in terms of model fit to the observed data, and adjusted to achieve a survey with high internal consistency among the items and factors (robust: $X^2p = 0.119$; CFI/TLI = 0.97/0.95; RMSEA = 0.06, SRMR = 0.041).

This document contains a detailed presentation of the pre- and post-validated survey instrument, in addition to the factor analysis diagram.

2 Document structure

This document includes the following:

- Confirmatory Factor Analysis diagram
- Pre-validated survey instrument
- Validated survey instrument

3 Note

The individual survey statements are listed in a tabular format with a reference to the original author and the code referring to the variable in the theoretical model. While a majority of the statements were used from existing studies, some survey items had to be adapted to fit the context of this study. In addition, no existing survey items related to the factor *Influence from computing people and role models* could be identified and thus the survey items were designed from scratch with an expert in the field [4]. For a full documentation on the survey design, refer to the original publication. When replicating this study or using the survey instrument for future research, it should be noted that the survey items in this document are ordered by factor, and the authors recommend mixing up the survey items prior to data collection.

4 Confirmatory Factor Analysis

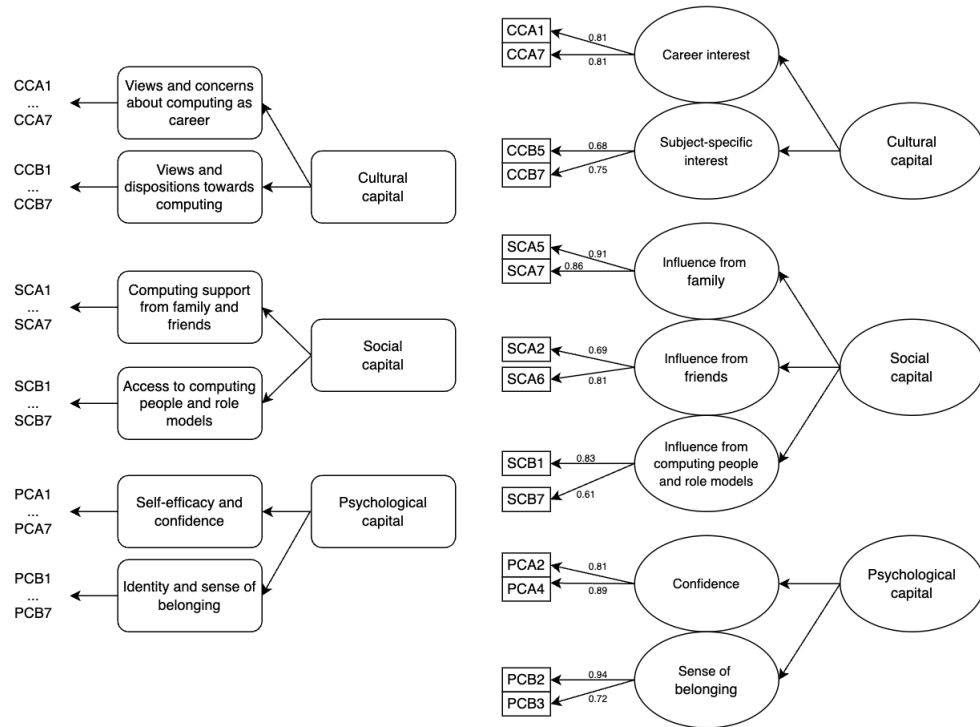


Figure 1: Pre-validated and validated survey instrument

5 Pre-validated survey instrument

5.1 Cultural Capital

CCA = Views and concerns about computing as career

CCB = Views and dispositions towards computing

Statement	Author	Code
After graduation, I would like to have a job in a computing-related field	Archer et al. [5]	CCA1
Computing is useful to achieve my goals in life	Archer et al. [5]	CCA2
A computer science or computing-related qualification can help you get many different types of jobs	Archer et al. [5]	CCA3
It is important to study basic computing even if I don't want to work in a computing-related job	Archer et al. [5]	CCA4
I would enjoy a career in a computing-related field	Hur et al. [6]	CCA5
A career in a computing-related field would enable me to work with others in meaningful ways	Hur et al. [6]	CCA6
Having a career in a computing-related field would be rewarding	Hur et al. [6]	CCA7
Providing young people with a basic understanding of computing is important for our society	Archer et al. [5]	CCB1
Computer science and computing creates new jobs so more people can have work	Archer et al. [5]	CCB2
It is useful to know about computers in my everyday life	Archer et al. [5]	CCB3
Tools and techniques from computing are useful in the study of other disciplines	Dorn & Elliot Tew [7]	CCB4
I find the challenge of solving problems with computers motivating	Dorn & Elliot Tew [7]	CCB5
Computing has little relation to what I experience in the real world	Dorn & Elliot Tew [7]	CCB6
I am interested in learning more about computers and computing	Dorn & Elliot Tew [7]	CCB7

5.2 Psychological Capital

PCA = Self-efficacy and confidence

PCB = Identity and sense of belonging

Statement	Author	Code
I am confident with using computers	Archer et al. [5]	PCA1
I am confident I can complete an undergraduate degree in computing	Nguyen and Lewis [8]	PCA2
I don't think I am clever enough to study computing at university	Archer et al. [5]	PCA3
I am confident I can learn the foundations and concepts of computing	Nguyen and Lewis [8]	PCA4
Compared to other people of my age I am good at using computers	Vekiri & Chronaki [9]	PCA5
When I do something new on the computer, I am confident that I can do well	Vekiri & Chronaki [9]	PCA6
I can usually figure out a way to solve problems related to computers	Dorn & Elliot Tew [7]	PCA7
I (would) enjoy being a computing student on my campus	Bell-Watkins et al. [10]	PCB1
I feel like I belong in computing	Lewis et al. [11]	PCB2
I see myself as a computing person	Lewis et al. [11]	PCB3
I feel like an outsider in the computing community	Lewis et al. [11]	PCB4
I consider myself a member of the computing community	Moudgalya et al. [12]	PCB5
I feel a connection with the computing community	Moudgalya et al. [12]	PCB6
If I were to work in a computing-related field, I expect to be treated fairly	Bell-Watkins et al. [10]	PCB7

5.3 Social Capital

SCA = Computing support from family and friends

SCB = Access to computing people and role models

Statement	Author	Code
One or more relatives (parent, aunt, chosen family) of mine: Has introduced me to computers or computing-related concepts at home	Archer et al. [5]	SCA1
One or more of my friends are interested in computers or computing	Vekiri & Chronaki [9]	SCA2
One or more relatives (parent, aunt, chosen family) of mine: Has explained to me that computers and computing are useful for my future	Archer et al. [9]	SCA3
One or more of my friends can help me with computing-related questions and problems	Vekiri & Chronaki [9]	SCA4
One or more relatives (parent, aunt, chosen family) of mine: Encouraged me to take an interest in computers or computing	Vekiri & Chronaki [9]	SCA5
One or more of my friends and I enjoy talking about computing or digital devices	Vekiri & Chronaki [9]	SCA6
One or more relatives (parent, aunt, chosen family) of mine: Encouraged me to study a computing-related subject in school or university	Vekiri & Chronaki [9]	SCA7
I am able to learn about computing from someone outside of my close environment (not family or friend)	Grande [4] & Kunkeler	SCB1
If I am interested in learning about a topic in computing, I am able to learn by observing what someone else does	Grande [4] & Kunkeler	SCB2
Someone outside of my close environment (not family or friend) who I have or had a relationship with, inspired me to take an interest in computing	Grande [4] & Kunkeler	SCB3
One or more people that I do not have a relationship with (for example, famous person), inspired me to take an interest in computing	Grande [4] & Kunkeler	SCB4
There are or have been people professionally involved in my education who inspired me to take an interest in computing	Grande [4] & Kunkeler	SCB5
There are one or more people (not family or friend) in a computing-related profession who I can talk to	Grande [4] & Kunkeler	SCB6
There are one or more people (not family or friend) in a computing-related profession whom I can learn from	Grande [4] & Kunkeler	SCB7

6 Validated survey instrument

Statement	CFA factor	Code
After graduation, I would like to have a job in a computing-related field	Career interest	CCA1
Having a career in a computing-related field would be rewarding	Career interest	CCA7
I find the challenge of solving problems with computers motivating	Subject-specific interest	CCB5
I am interested in learning more about computers and computing	Subject-specific interest	CCB7
One or more relatives (parent, aunt, chosen family) of mine: Encouraged me to take an interest in computers or computing	Influence from family	SCA5
One or more relatives (parent, aunt, chosen family) of mine: Encouraged me to study a computing-related subject in school or university	Influence from family	SCA7
One or more of my friends are interested in computers or computing	Influence from friends	SCA2
One or more of my friends and I enjoy talking about computing or digital devices	Influence from friends	SCA6
I am able to learn about computing from someone outside of my close environment (not family or friend)	Influence from computing people and role models	SCB1
There are one or more people (not family or friend) in a computing-related profession whom I can learn from	Influence from computing people and role models	SCB7
I am confident I can complete an undergraduate degree in computing	Confidence	PCA2
I am confident I can learn the foundations and concepts of computing	Confidence	PCA4
I feel like I belong in computing	Sense of belonging	PCB2
I see myself as a computing person	Sense of belonging	PCB3

References

- [1] T. Kunkeler and A. Nylén, “Capital in Computing Education: Investigating Factors Underlying Participation,” in *Proceedings of the 2024 Conference on Innovation and Technology in Computer Science Education*, (Milan, Italy), ACM, July 2024.
- [2] P. Bourdieu, “The forms of capital,” in *Handbook of Theory and Research for the Sociology of Education* (J. G. Richardson, ed.), p. 241–58, Greenwood, 1986.
- [3] M. Kallia and Q. Cutts, “Re-examining inequalities in computer science participation from a bourdieusian sociological perspective,” in *Proceedings of the 2021 ACM Conference on International Computing Education Research*, ICER ’21, pp. 379–392, Association for Computing Machinery, 2021.
- [4] V. Grande, “Lost for words! defining the language around role models in engineering education,” in *2018 IEEE Frontiers in Education Conference (FIE)*, pp. 1–9, 2018.
- [5] L. Archer, E. Dawson, J. DeWitt, A. Seakins, and B. Wong, ““science capital”: A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts,” *Journal of Research in Science Teaching*, vol. 52, no. 7, pp. 252–259, 2015.
- [6] J. W. Hur, C. E. Andrzejewski, and D. Marghitu, “Girls and computer science: experiences, perceptions, and career aspirations,” *Computer Science Education*, vol. 27, no. 2, pp. 100–120, 2017.
- [7] B. Dorn and A. Elliott Tew, “Empirical validation and application of the computing attitudes survey,” *Computer Science Education*, vol. 25, no. 1, pp. 1–36, 2015.
- [8] A. Nguyen and C. M. Lewis, “Competitive enrollment policies in computing departments negatively predict first-year students’ sense of belonging, self-efficacy, and perception of department,” in *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, SIGCSE ’20, pp. 685–691, Association for Computing Machinery, 2020.
- [9] I. Vekiri and A. Chronaki, “Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school,” *Computers & Education*, vol. 51, no. 3, pp. 1392–1404, 2008.
- [10] K. Bell-Watkins, T. Barnes, and N. Thomas, “Developing computing identity as a model for prioritizing dynamic k-12 computing curricular standards,” *Journal of Computing Sciences in Colleges*, vol. 24, no. 3, pp. 125–131, 2009.

- [11] C. Lewis, P. Bruno, J. Raygoza, and J. Wang, “Alignment of goals and perceptions of computing predicts students’ sense of belonging in computing,” in *Proceedings of the 2019 ACM Conference on International Computing Education Research*, ICER ’19, pp. 11–19, Association for Computing Machinery, 2019.
- [12] S. K. Moudgalya, C. Mayfield, A. Yadav, H. H. Hu, and C. Kussmaul, “Measuring students’ sense of belonging in introductory CS courses,” in *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, SIGCSE ’21, pp. 445–451, Association for Computing Machinery, 2021.