

# Examining educational technology and achievement through latent variable modeling

Elena C. Papanastasiou,  
Intercollege,  
& European Psychometric Service

Efi Papparistodemou  
Ministry of Education, Cyprus

# Introduction

- The use of computers in the teaching and learning of mathematics has been constantly increasing.
- Numerous technology-related studies have been undertaken in the last decades in connection to various areas of mathematics such as algebra, geometry, probability and statistics (Olivero, 2001; Paparistodemou & Noss, 2004).
- The common aspect of these studies is their attempt to effectively use educational technology to improve student's understanding of mathematics.

# ...introduction

- However, this is not a simple task.
  - The relationship between computer use and achievement is constantly transformed by the increasing presence of computers in everyday life, and by our increasing reliance on computer technologies.
- → As a result, educators need to constantly adapt their practices to meet the educational needs of the students.

# Literature review

- For example, although we are all aware of the positive effects of educational technology, a series of studies have found some inverse relationships between computer use and achievement.
- These studies have found that students who use computers most frequently tend to have lower achievement in mathematics

# ... literature review

- The inverse relationships between computer use and achievement have been found in various datasets e.g.
- The Educational Testing Service (Wenglinsky, 1998)
- TIMSS (Papanastasiou, 2002), TIMSS-R (Papanastasiou, Zembylas & Vrasidas, 2005).
- PISA (Papanastasiou, Zembylas & Vrasidas, 2005).

# ... literature review

- Note:

1) The inverse relationships between computer use and achievement were found in aggregated results of large datasets.

2) The inverse relationships were NOT found in experimental studies.

# The purpose of this study is...

- ...to propose and test an SEM model concerning the current relationship between technology use and mathematics achievement, after controlling for the student's educational background.
- Countries:
  - USA
  - Cyprus
  - Russian Federation
  - South Africa

# Sampled country characteristics

Country	Size	Achievement	% home computers
Cyprus	Small	Below average (459)	82%
South Africa	Large	Lowest average TIMSS score (264)	37%
Russian Federation	Large	Above average (508)	30%
USA	Large	Above average (504)	93%

# Methods

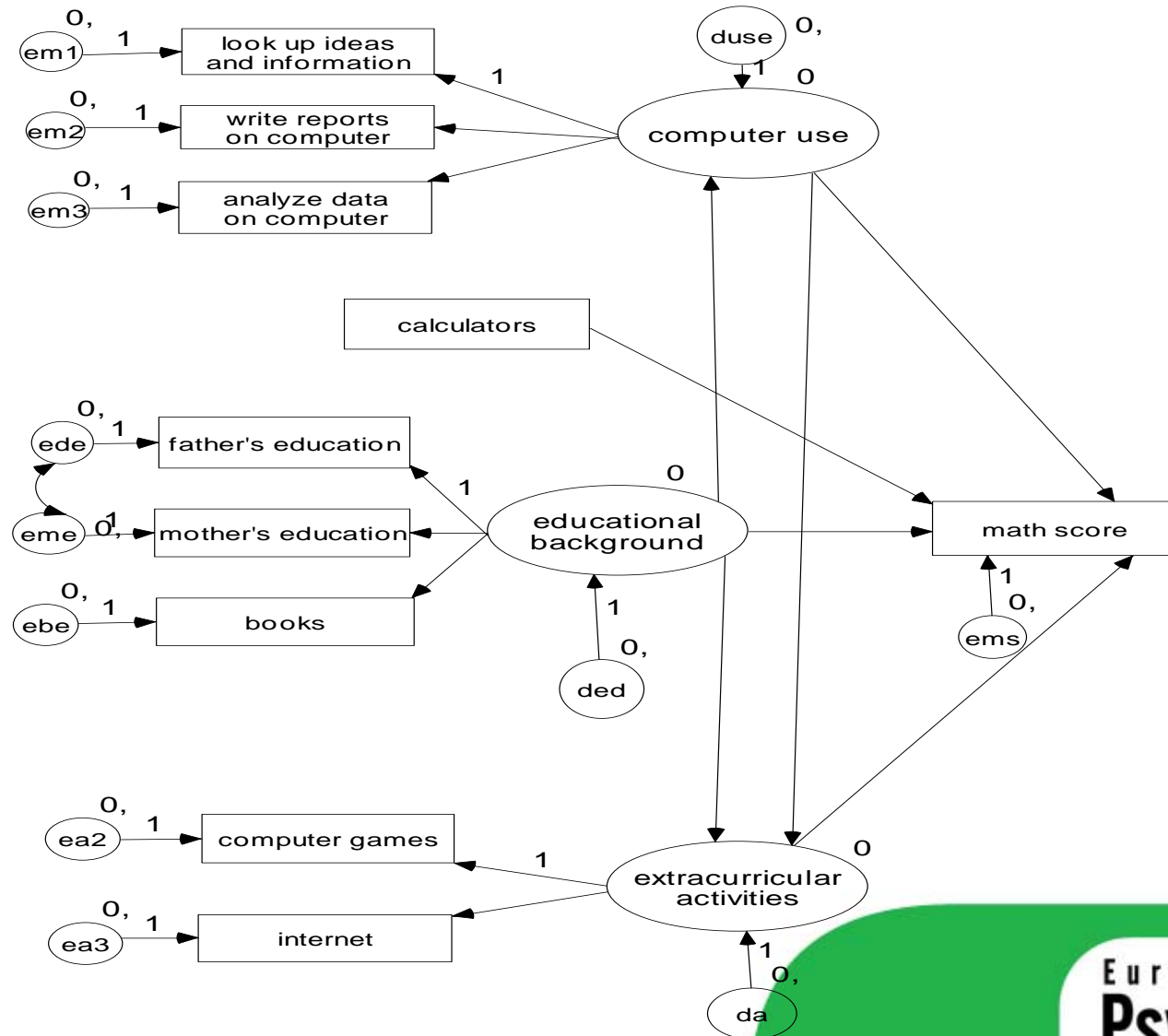
- **Analysis**
  - Structural equation modeling
- **Software**
  - AMOS 5.0.1
- **Dataset**
  - TIMSS 2003
- **Sample characteristics**

	N	%females
– Cyprus	4002	48.6%
– Russian Federation	4667	50.0%
– South Africa	8840	50.6%
– USA	8912	51.9%

<b>Items used in the analysis</b>	<b>Variable type</b>
<b>Math score – Dependent variable</b>	Observed
<b>Educational background</b>	Latent
Father's education	Observed
Mother's education	Observed
Books at home	Observed
<b>Computer use</b>	Latent
Look up ideas and information for math (with a computer)*	Observed
Write reports for school (with a computer)*	Observed
Process and analyze data (with a computer)*	Observed
<b>(Computer related) extracurricular activities</b>	Latent
I play computer games (before or after school)	Observed
I use the internet (before or after school)	Observed
How often do you use calculators in your math lessons*	Observed

\* *Recoded variables*

# Hypothesized model



# Model fit results

Table 2. Fit Indices across countries

	Cyprus	Russian Federation	South Africa	USA
$\chi^2$	338.87 (p=0.00)	61.84 (p=0.00)	839.92 (p=0.00)	553.63 (p=0.00)
$\chi^2/df$	11.69	2.13**	28.96	19.09
NFI	0.94 *	0.99**	0.90*	0.95**
CFI	0.94 *	0.96**	0.90*	0.96**
TLI	0.89*	0.99**	0.81	0.92*
RMSEA	0.05**	0.02**	0.06**	0.05**
<b>R<sup>2</sup> (math score)</b>	<b>38%</b>	<b>25%</b>	<b>50%</b>	<b>43%</b>

\* good fit

\*\*very good fit

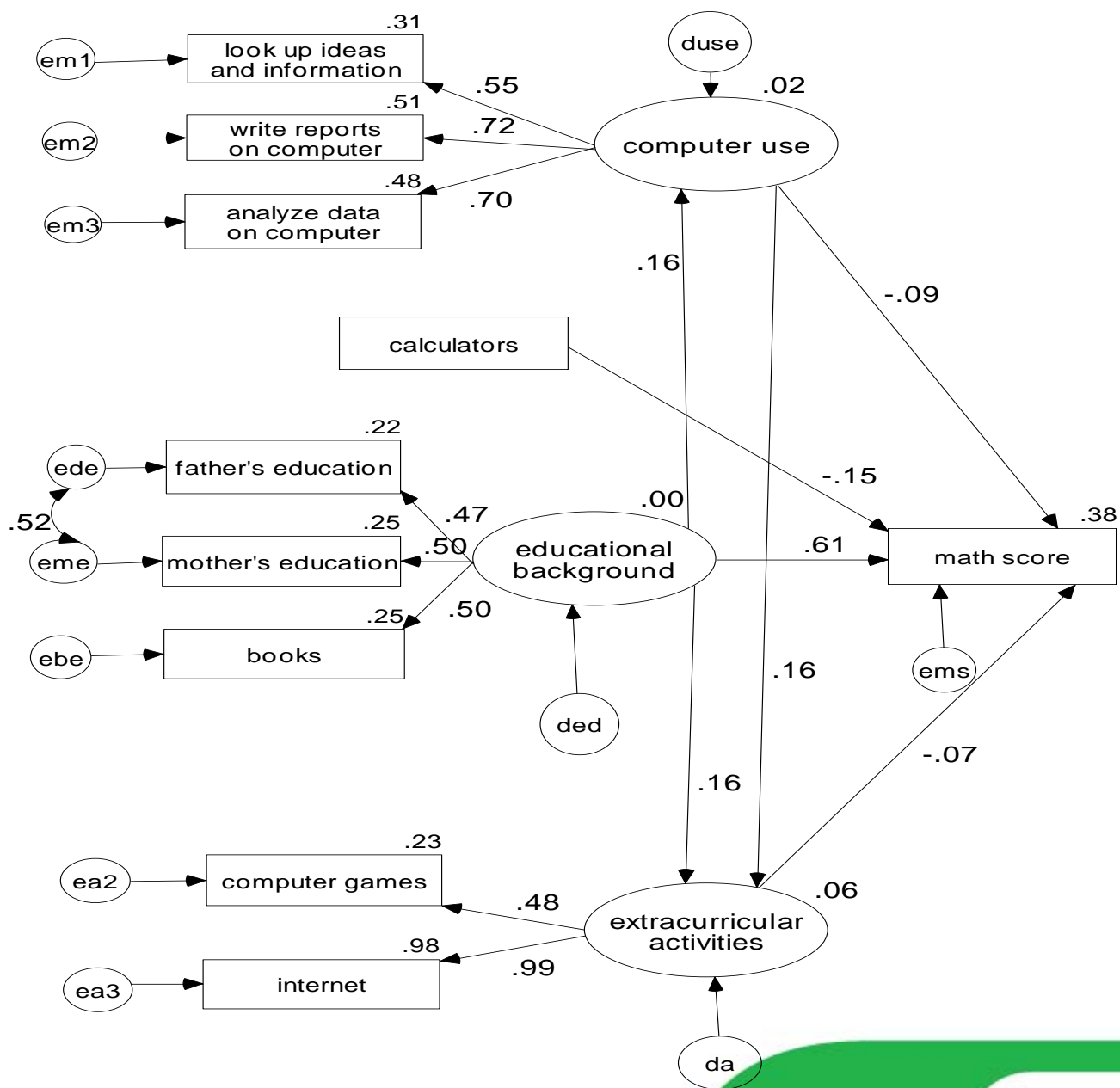


Figure 2. Cyprus model results

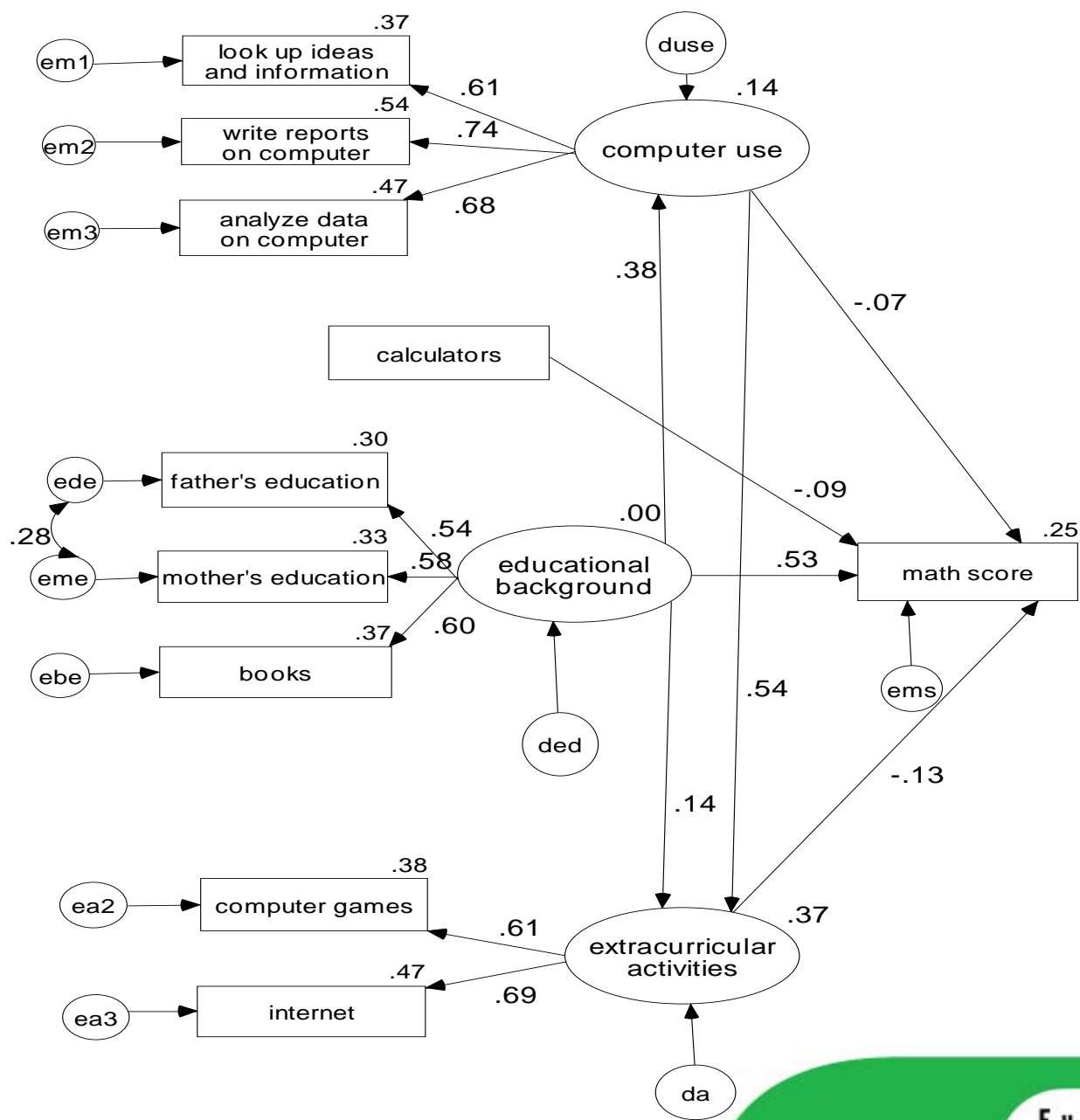


Figure 3. Russian Federation model results

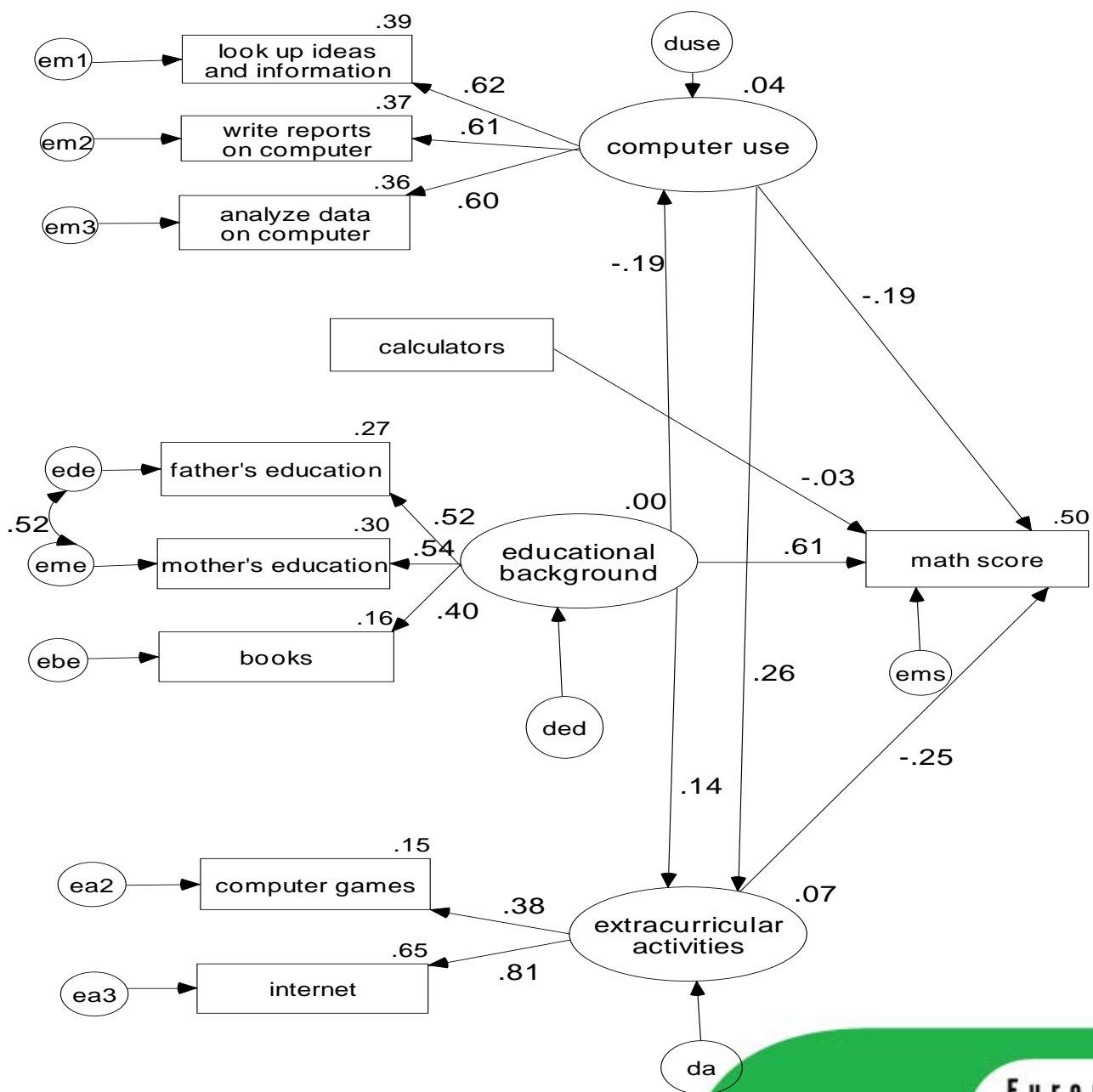


Figure 4. South African model results

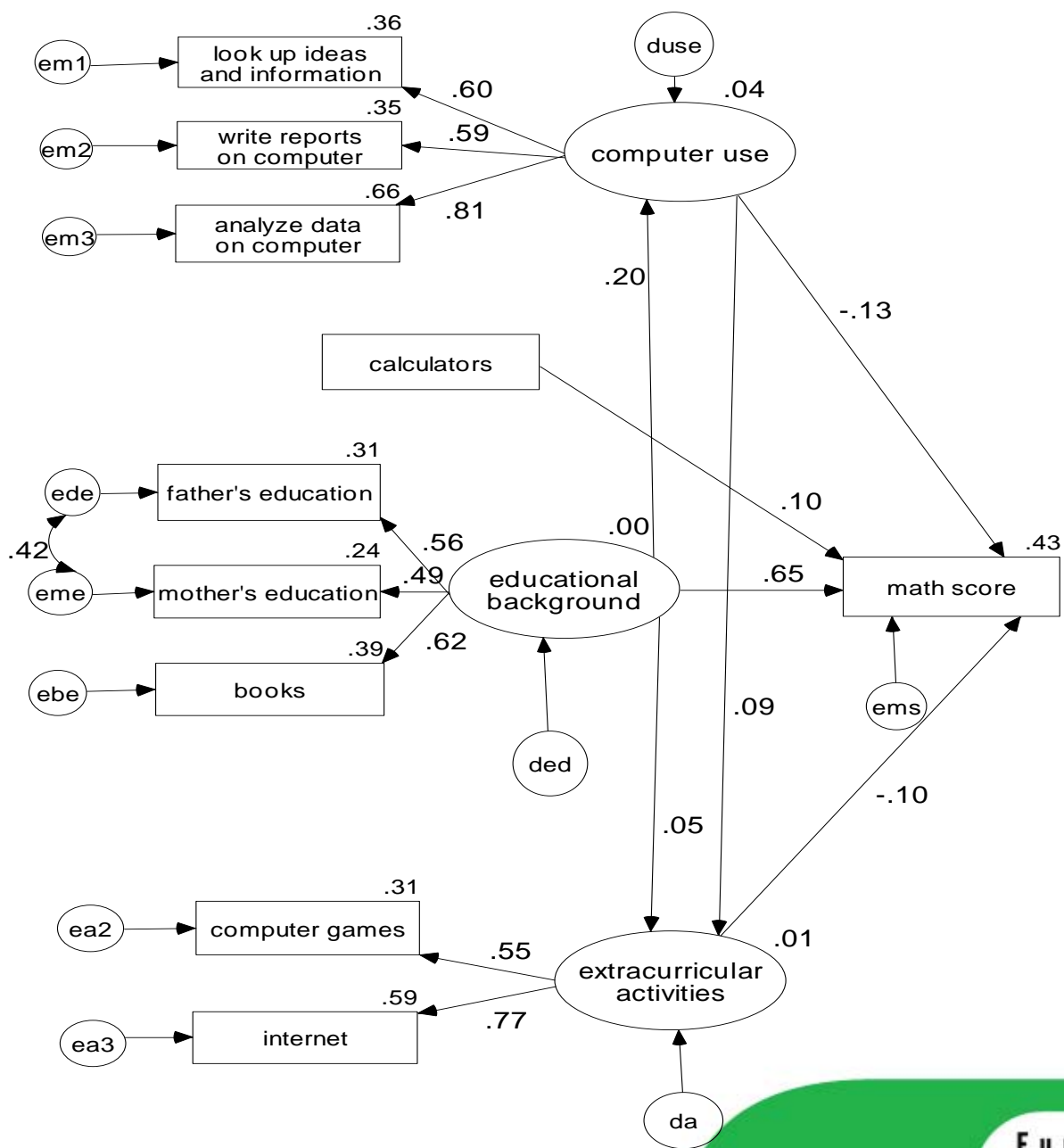


Figure 5. USA model results

Standardized regression weights by country

			Standardized regression weights			
			Cyprus	Russian Federation	South Africa	USA
Computer use	→	<b>Math score</b>	-.086	-.065	-.189	-.133
Extracurricular activities	→	<b>Math score</b>	-.074	-.132	-.248	-.100
Educational background	→	<b>Math score</b>	.614	.533	.605	.654
Use calculators	→	<b>Math score</b>	-.152	-.089	-.026	.105
Educational background	→	Computer use	.156	.377	-.195	.200
Educational background	→	Extracurricular activities	.162	.144	.144	.051
Computer use	→	Extracurricular activities	.156	.542	.262	.093

# Overall results

1. Educational background has the largest effect on mathematics achievement
  - children of stronger educational backgrounds are advantaged in school
2. The paths between technology use and achievement tend to be small and negative.

## ... overall results

3. The use of calculators in mathematics did not have any practically significant effect in the Russian Federation and in South Africa.
- However the use of calculators was ...
    - negatively associated with mathematics achievement in Cyprus
    - positively associated with achievement in the USA.

# Conclusions

- The results of this study are a bit disappointing
  - Educational variables are still unable to surpass the effects of SES and educational background
  - Frequent use of technology related activities are not associated with higher achievement
    - A possible interpretation is that these specific computer related activities are not advantageous for mathematics education.
      - However, such activities might help increase other skills (e.g. technological literacy).
    - These results could also be due to the specific questionnaire items that were administered.
      - They do not specify where and how the computer related activities took place
      - They are not always math-related

# ... conclusions

- The silver lining...
  - Higher levels of calculator use is associated with higher achievement in the USA
    - The numerous years of research on calculator use in the USA must have finally paid off.
  - In Cyprus however where the use of calculators is not encouraged, and where calculator use research has not taken place, the results are not as encouraging.

# Final remarks

- Most likely, technology use in schools has not reached its full potential.
- However, as was the case with calculators in the USA, more research in educational technology needs to take place to be able to reach its full potential .

# A final suggestion

- It would be especially useful if the questionnaires included more detailed questions on how technology is used...
  - in the classroom
  - at home
  - for each subject area (math and science)
  - by the teachers
  - by the students