SEEDS OF CHANGE:
The Role of Informal Science Education in the 21st Century

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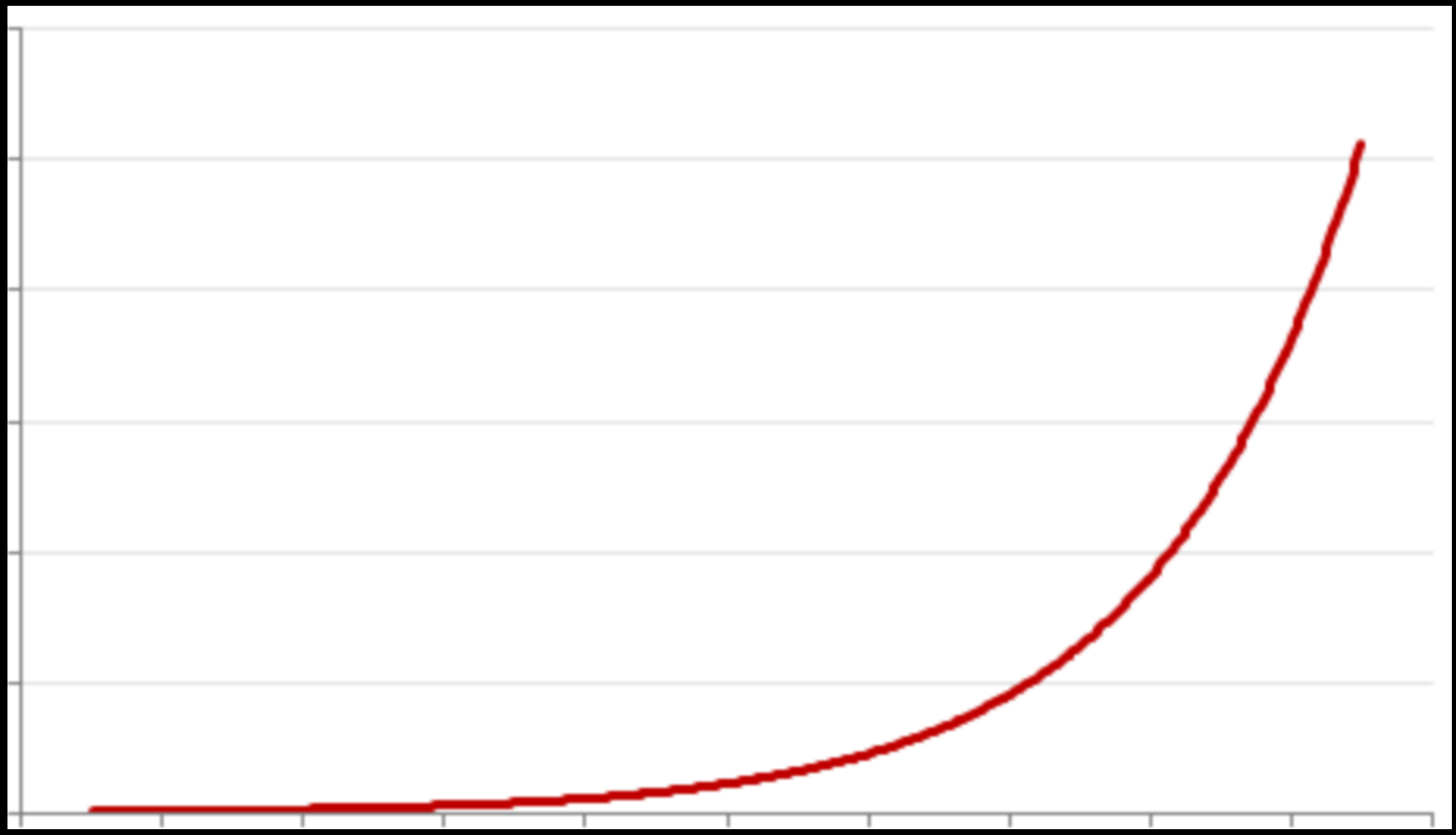
Overview

- 21st Century Context
- Why do people learn science?
- Where do people learn science?
- How important are informal science education institutions?
- What are the implications for ISE institutions in Texas?

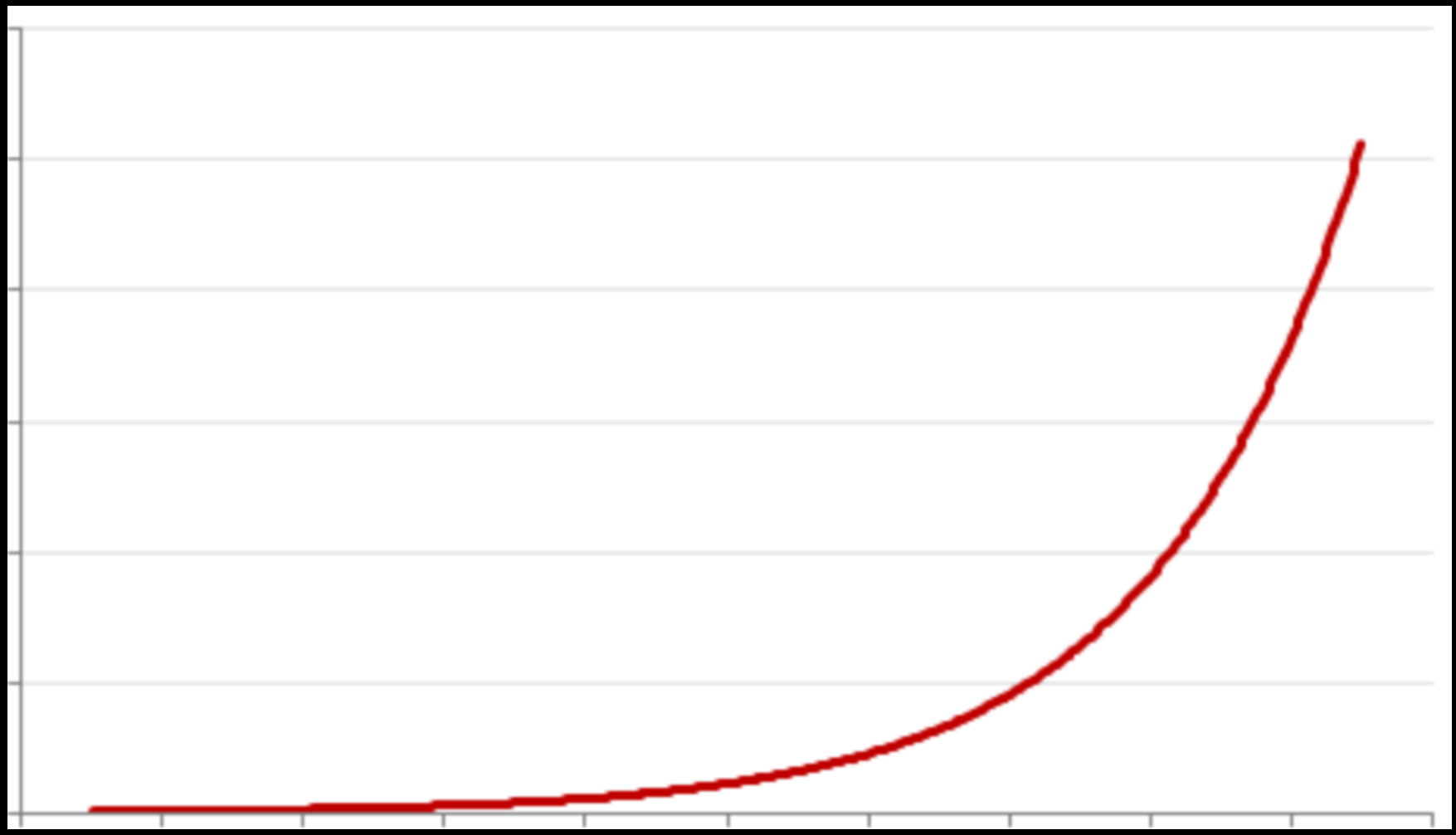
21st Century Realities

The World is Changing:
Data Stored on a Single Chip



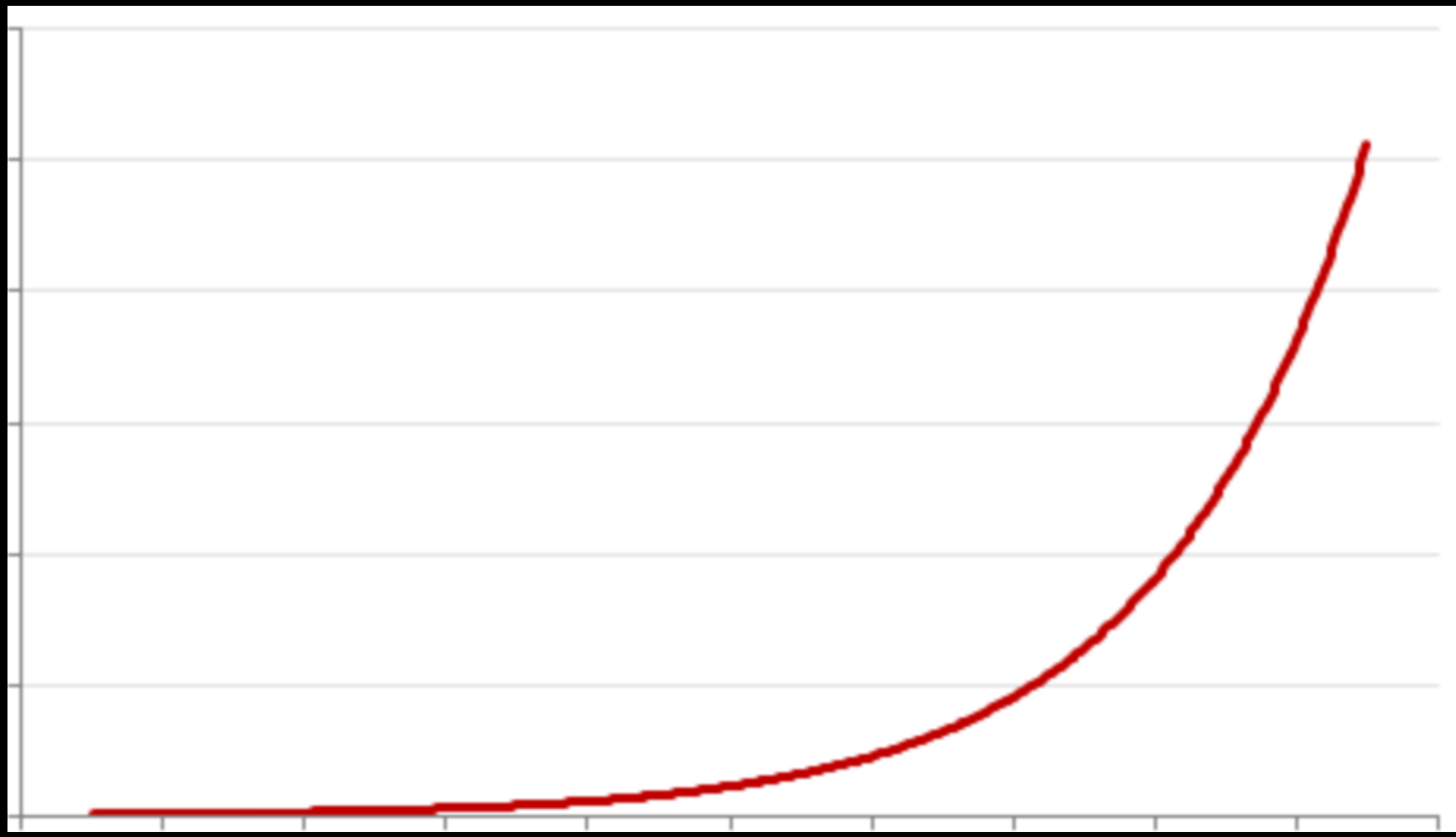
1976 1981 1986 1991 1996 2001 2006 2011 2016 2021 2026

The World is Changing:
Growth in Solar Power



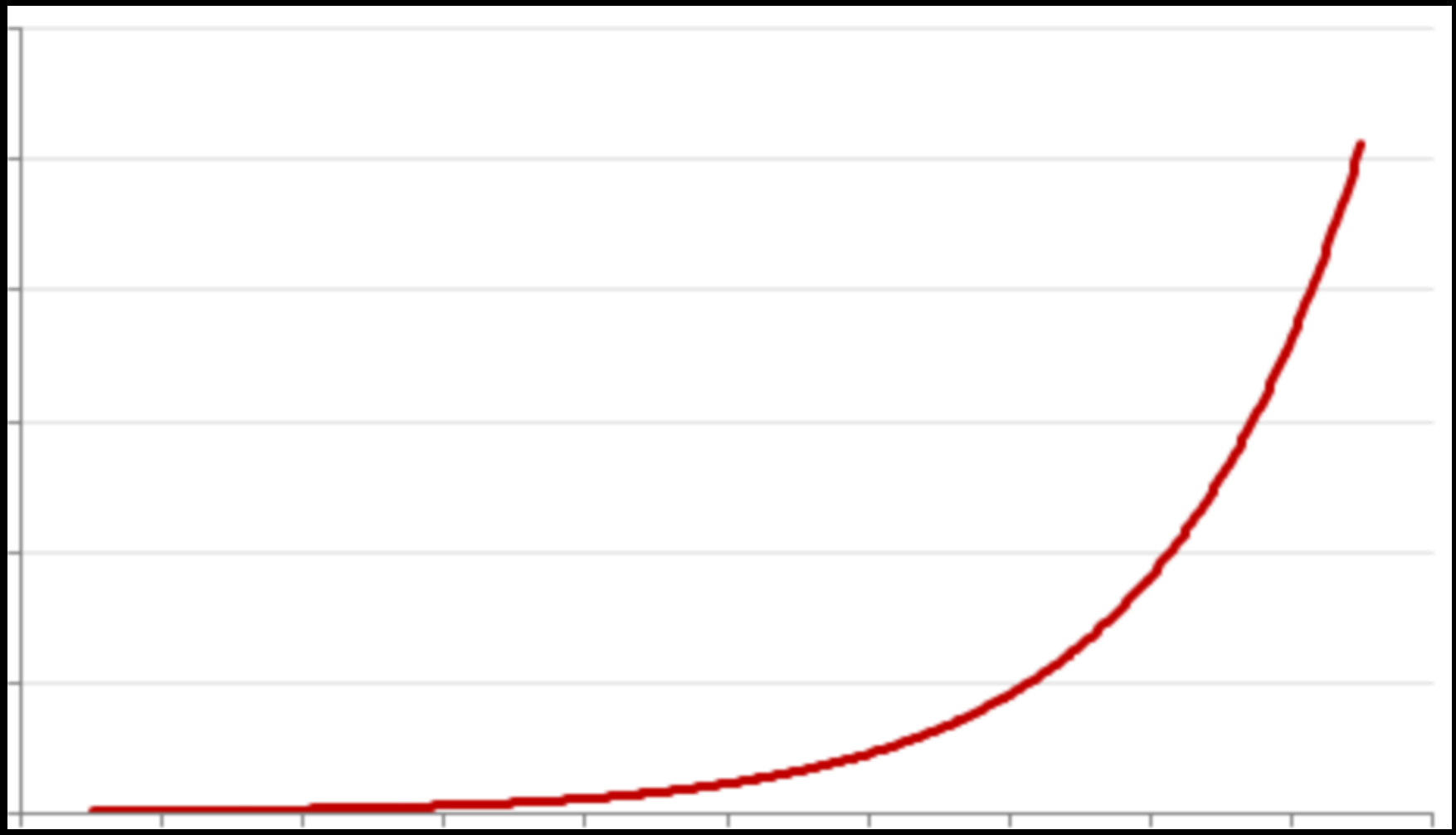
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

The World is Changing:
Number of Programming Jobs



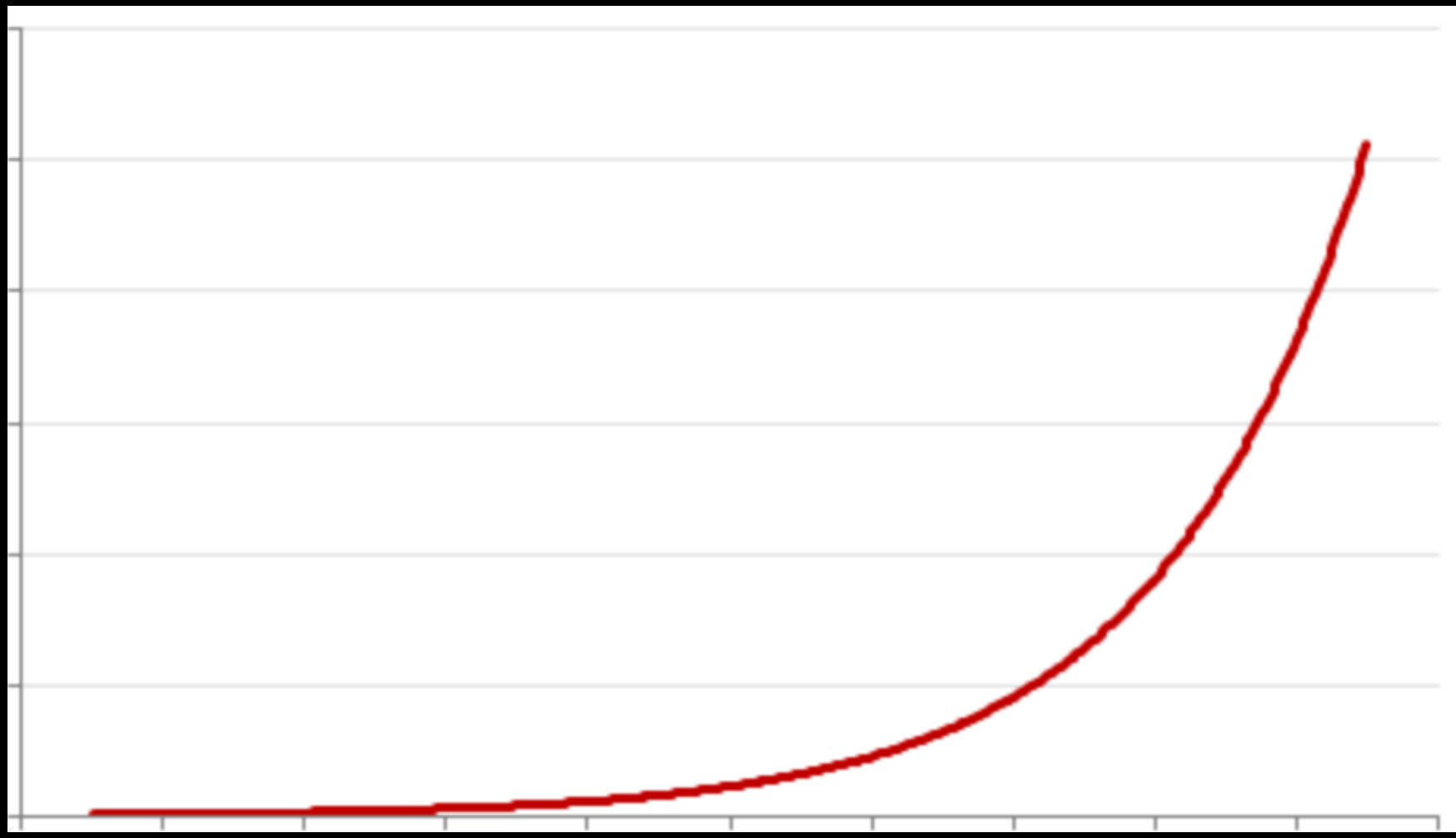
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

The World is Changing:
Carbon Dioxide in the Atmosphere



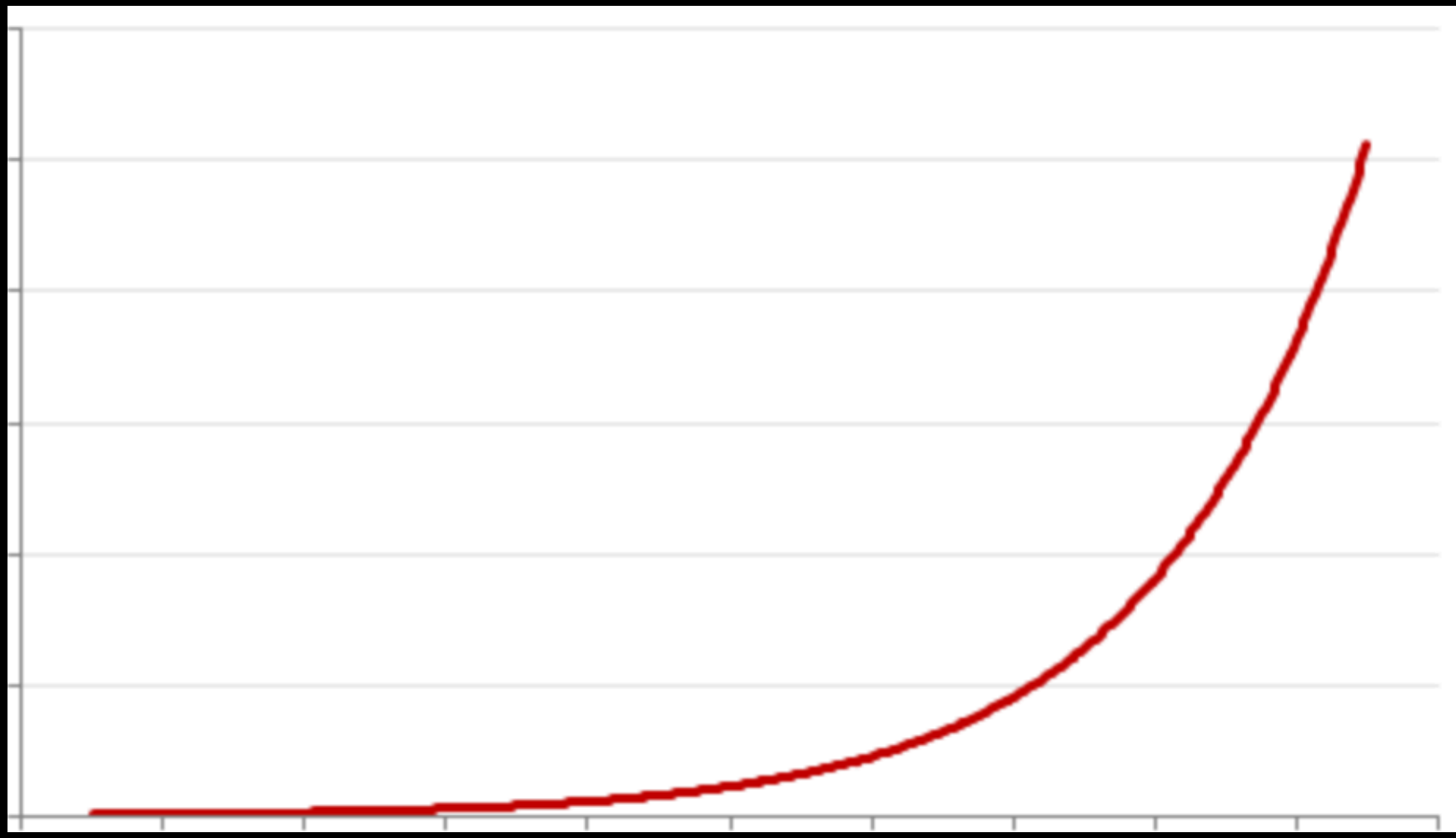
1765 1790 1815 1840 1865 1890 1915 1940 1965 1990 2015

The World is Changing:
Urban Population



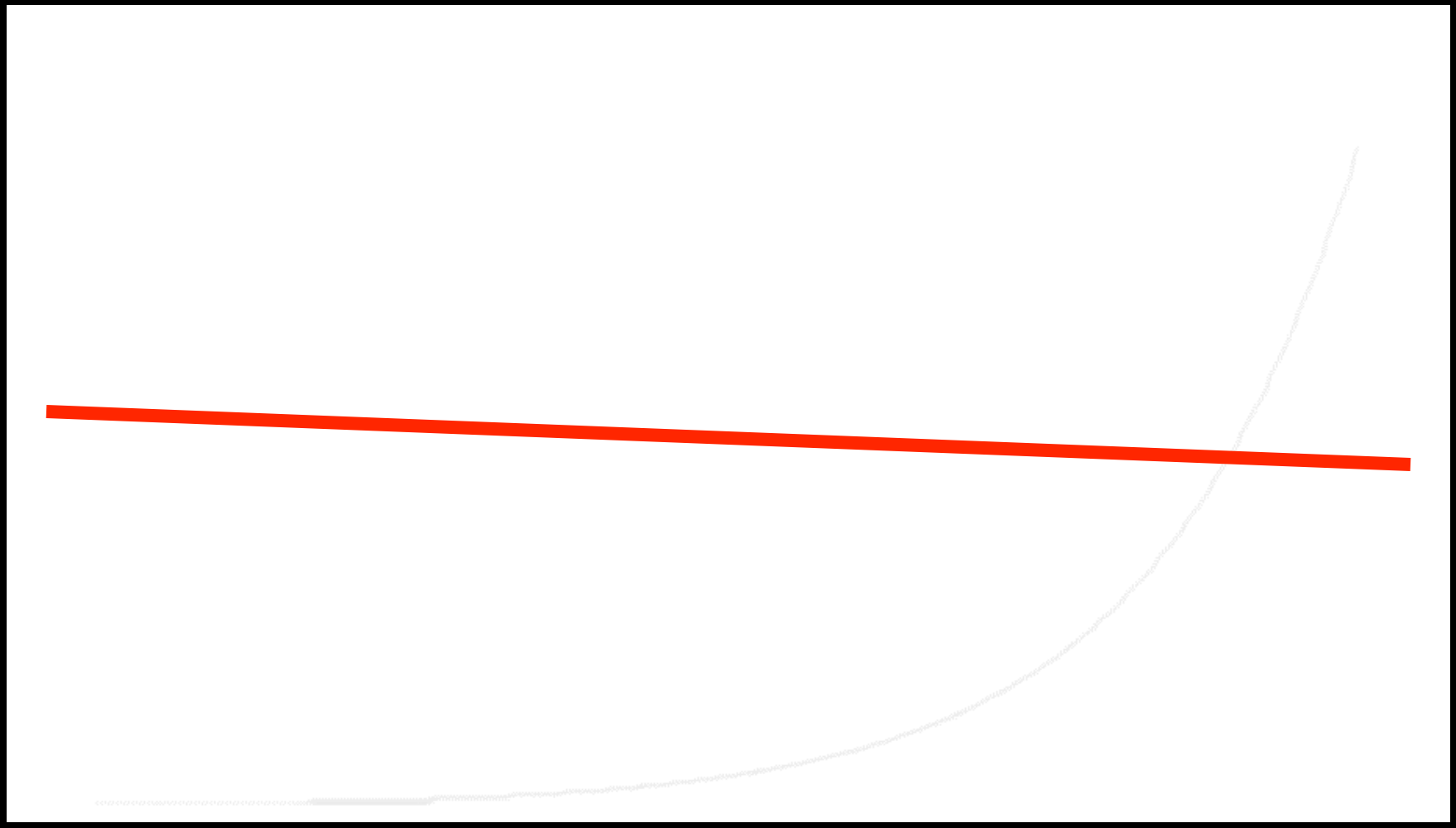
1765 1790 1815 1840 1865 1890 1915 1940 1965 1990 2015

The World is Changing:
Number of Cell Phones in World



2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

The World is Changing:
Hours of U.S. Elem. Science Instruction



Fundamental Realities About Science Learning Today

- Science learning is lifelong: 24-7-365-70+
- Less then 9% of a child's life is spent in formal instruction; over a lifetime less than 2%
- Traditional gatekeepers of science knowledge – schools, libraries, government – are no longer in total control
- The boundaries between where, when and why we learn science are disappearing
- Science learning is continuous & cumulative

Why Do People Learn Science?

People Learn Science

1. Satisfy Personal Curiosity/Interest
2. On-the-Job Experience/Training
3. For a Hobby
4. To Support the Needs of Others (e.g., children)
5. Satisfy a Need (illness, environmental problem, etc.)
6. For School or other Career-Related Needs

Falk, Storksdieck & Dierking, 2007; Dierking & Falk, 2009

Everyday Science Interviews

- Utilized a “crowd sourced” methodology – enlisted Science education community to act as “citizen” researchers
- Data collected by citizens, colleagues and college science education students using a simple interview protocol
- Asked friends and relatives what science & technology learning, broadly defined, they engaged in, posted results to website?
- Currently, n > 450 individuals

Science/Technology Topics People Actively Learn About

90% of adults said their interest started during adolescence!

Where Do People Learn Science?

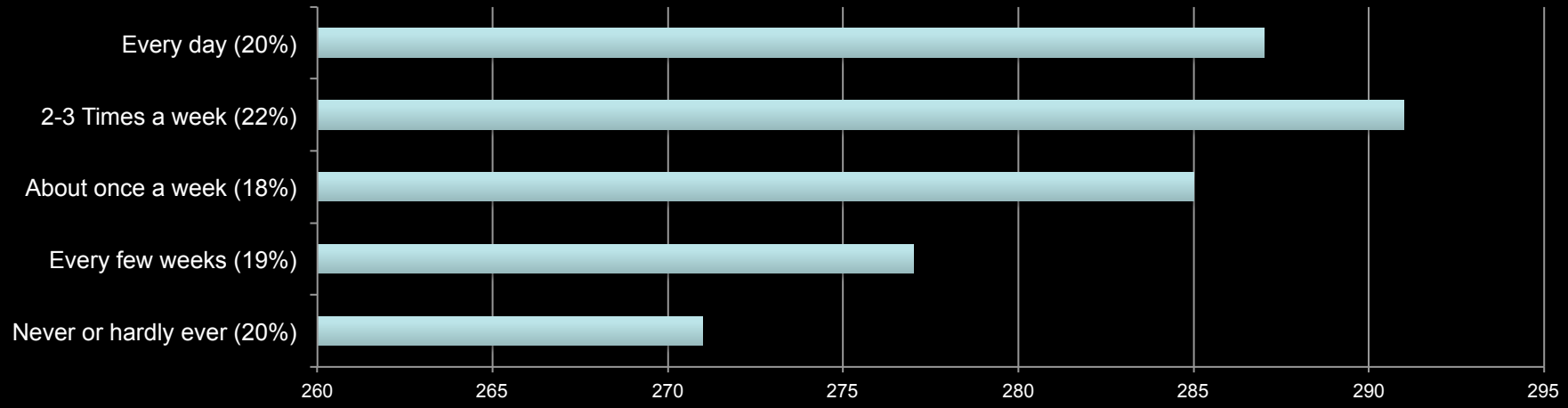
Widely Assumed that School is the Primary Source of the Public's Science Learning.

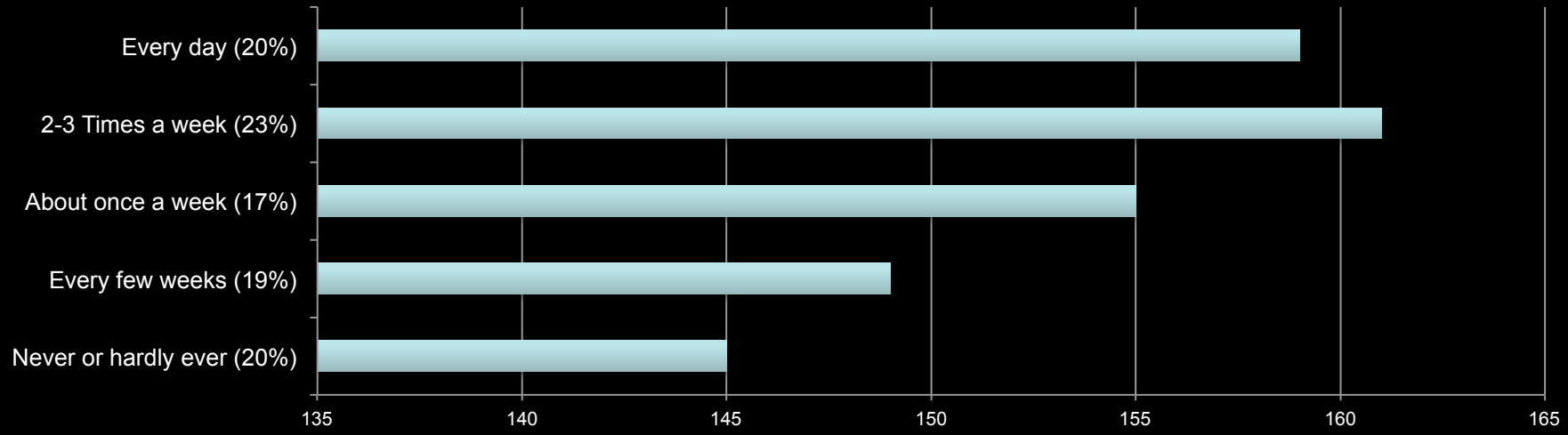
A comprehensive review of schooling revealed that:

- Only 20% of the variance in student success was related to schools – teachers (13%) and school qualitys (7%).
- The remaining 80% of the variation in student achievement was related to prior knowledge (41%), home environment (33%), interest and motivation (14%), and aptitude (12%).

Goodwin, B. (2011).

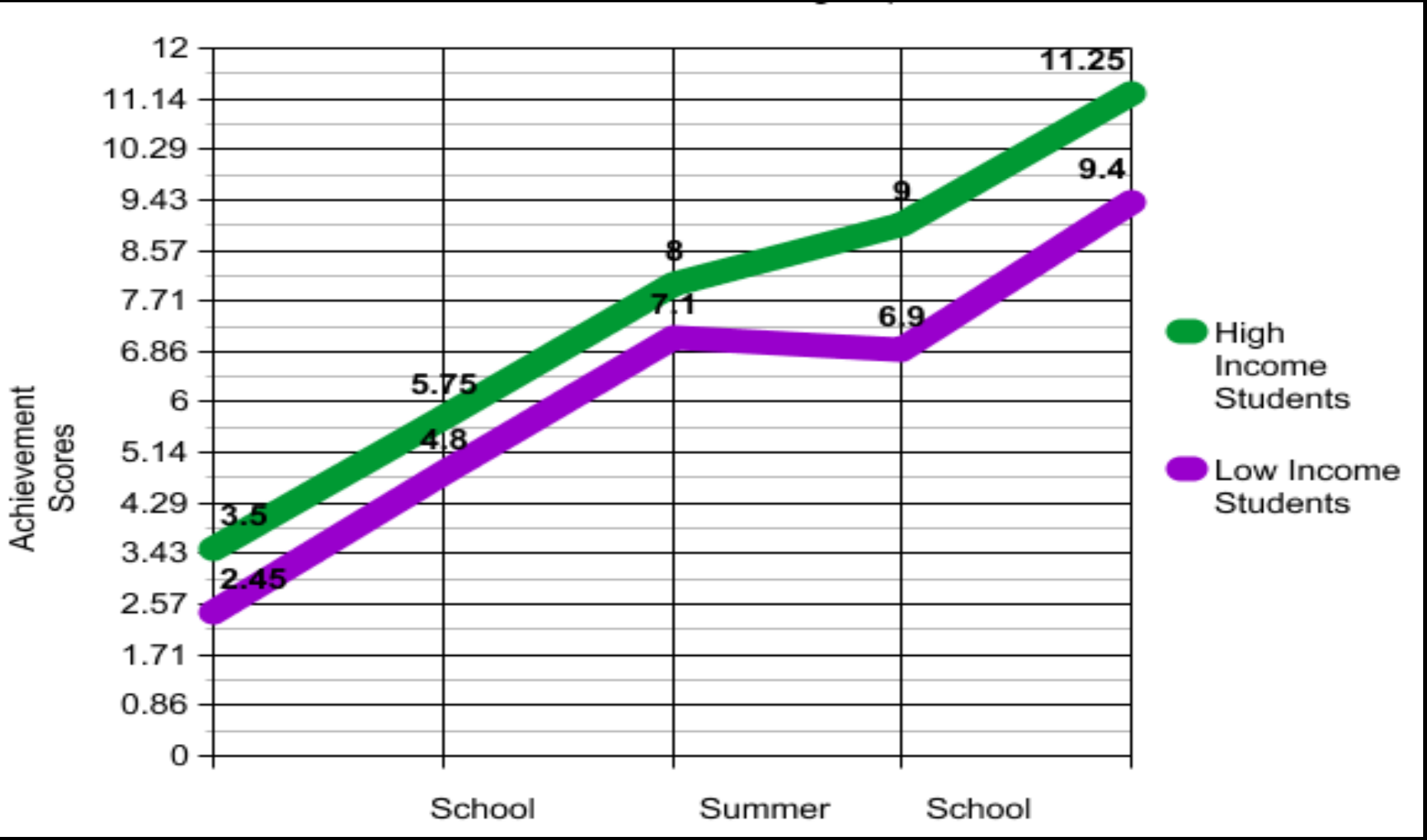
Parental Engagement Essential





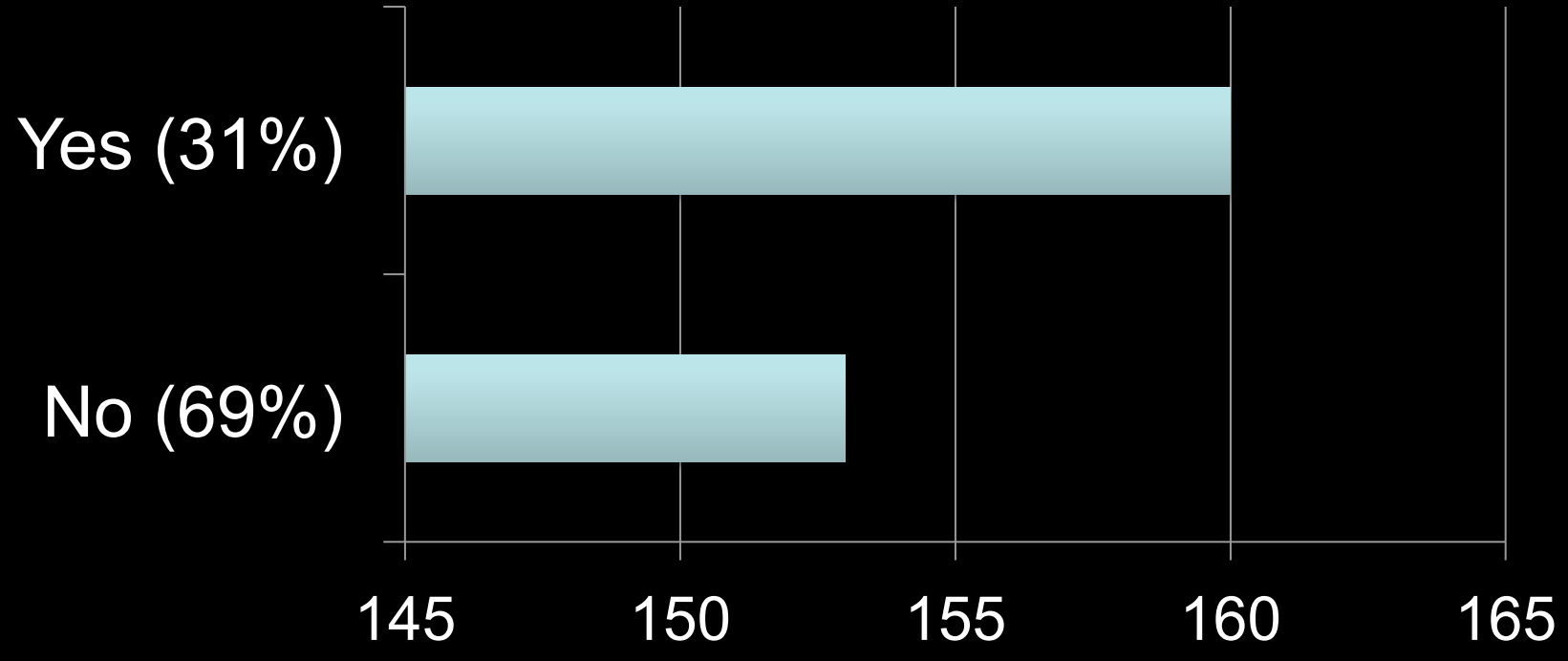
2015 NAEP Math & Science Scores X Parental Engagement

Reinforcing the importance of out-of-school



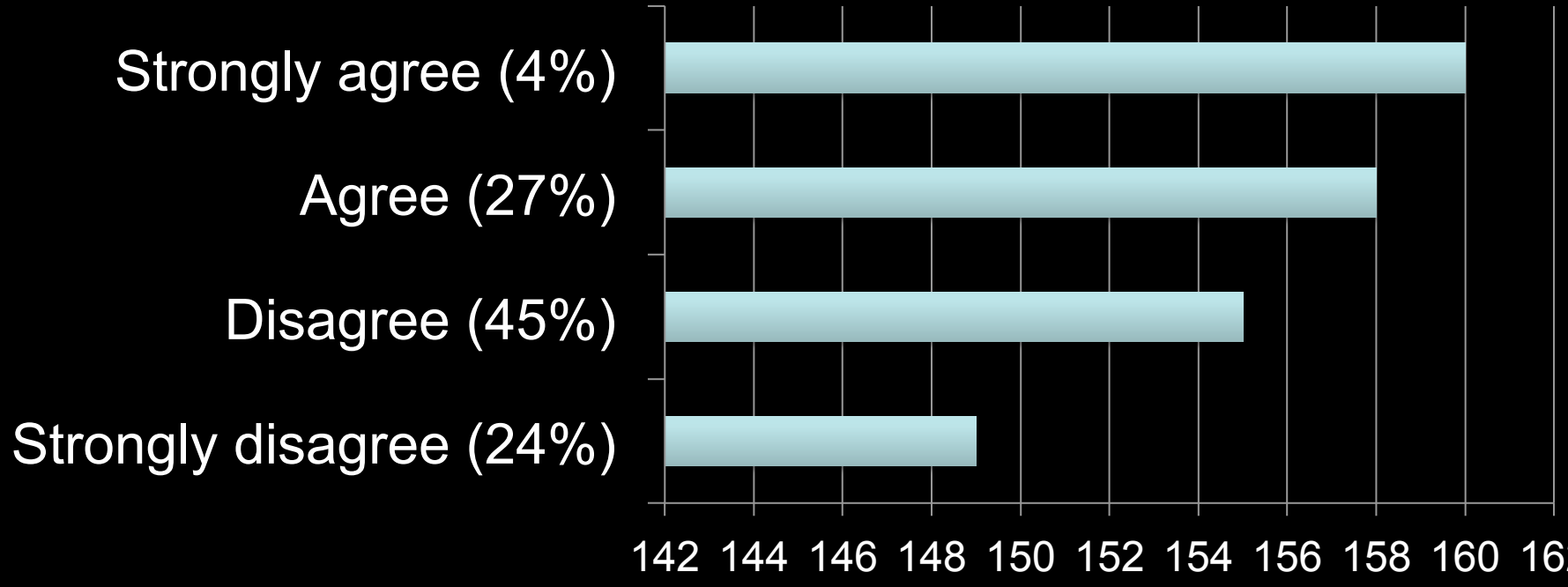
Von Hippel, et al., 2007; also Alexander, et al., 2007

Role of Informal Education Experiences Outside of School



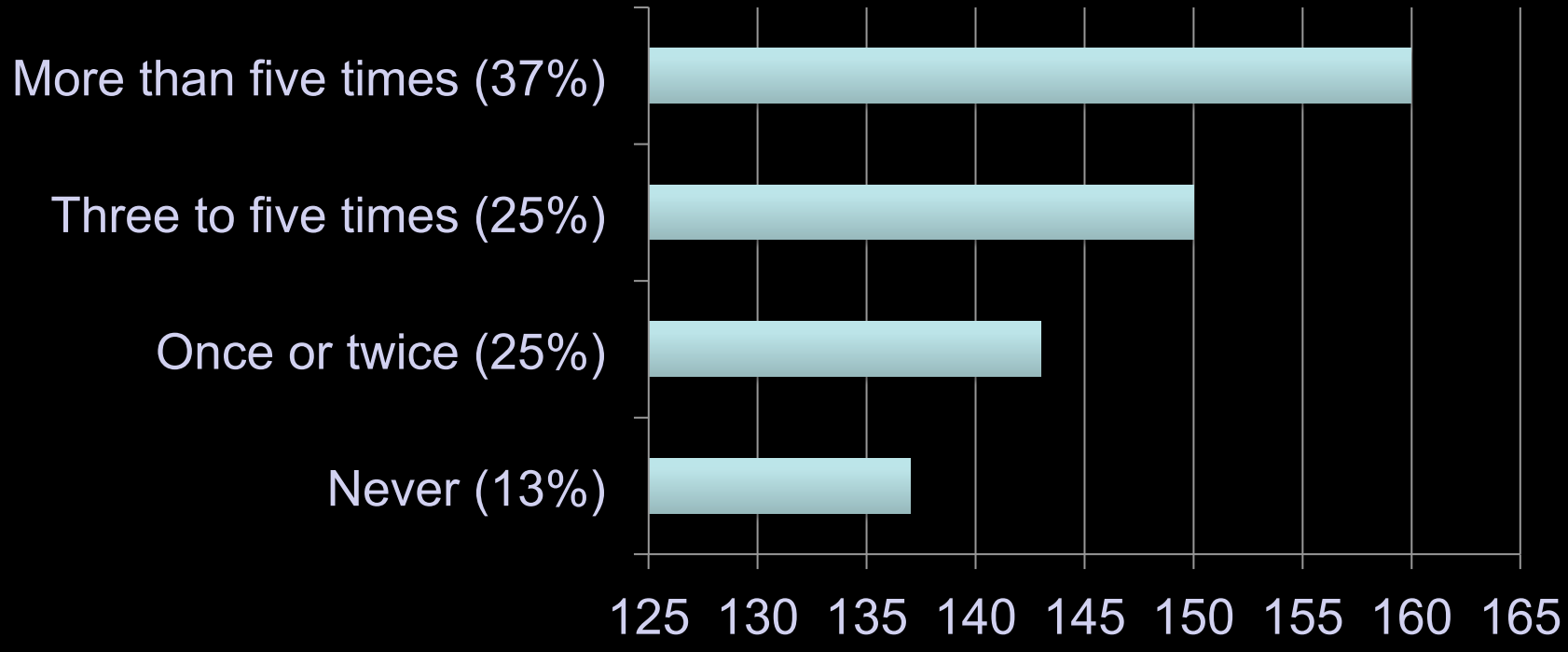
2015 NAEP results for the question: "*In this school year, have you visited a museum, zoo, or aquarium to learn about science that was not on a school trip?*"

And Free-Choice Learning Activities Generally



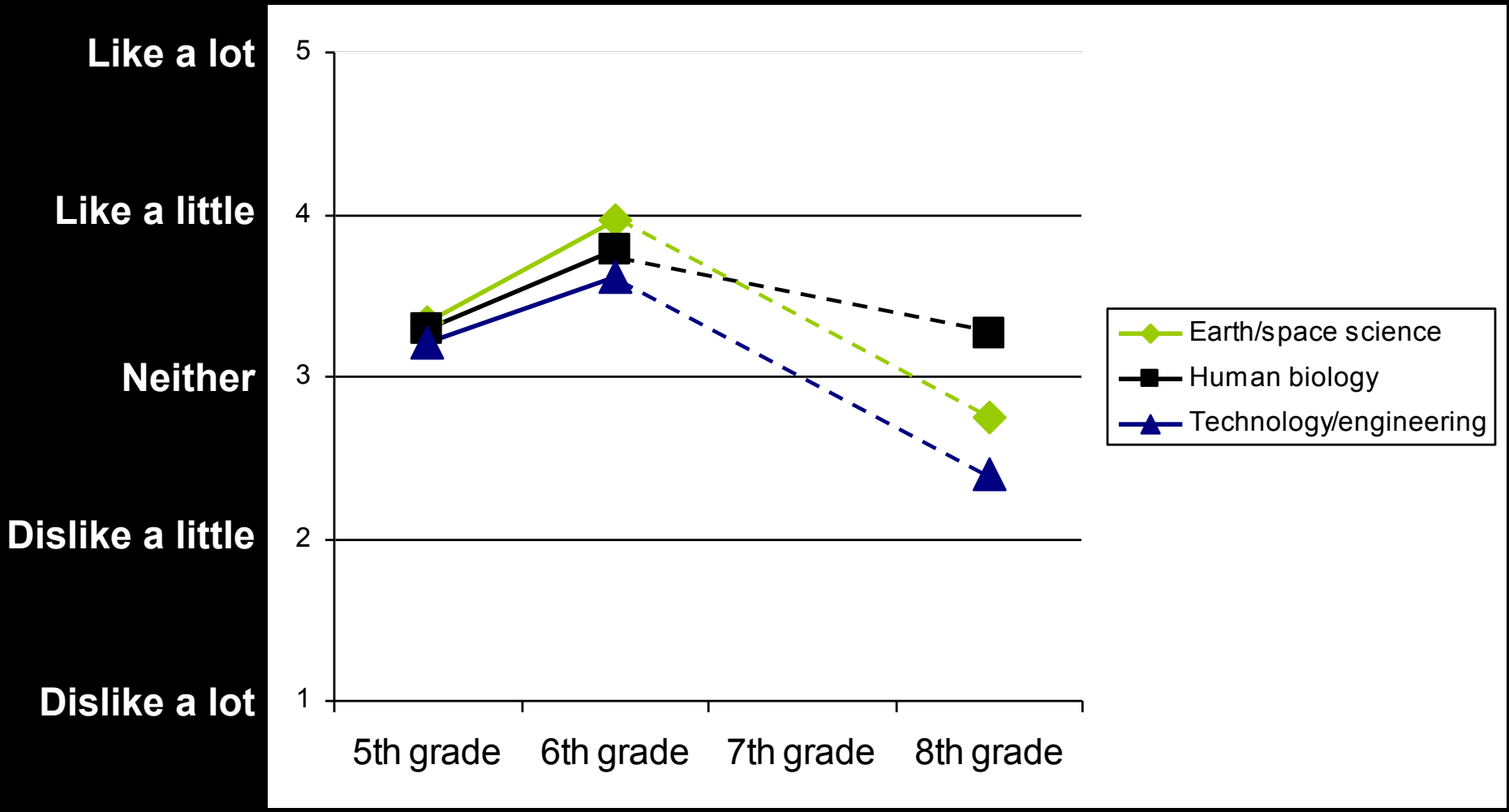
2015 NAEP results for the question: "*Please indicate how much you disagree or agree with the following statement about science: I do science-related activities that are not for schoolwork.*"

Free-Choice Activities particularly important in Technology & Engineering



2014 NAEP Technology & Engineering Literacy results for the question: "*Outside of school, how often have you ever figured out why something is not working in order to fix it?*" NOTE: Proficient = 158+

Science Interests Over Time



Falk, Dierking, Staus, Penuel, Wyld & Bailey (2016)

Factors Contributing to Science Interest Decline

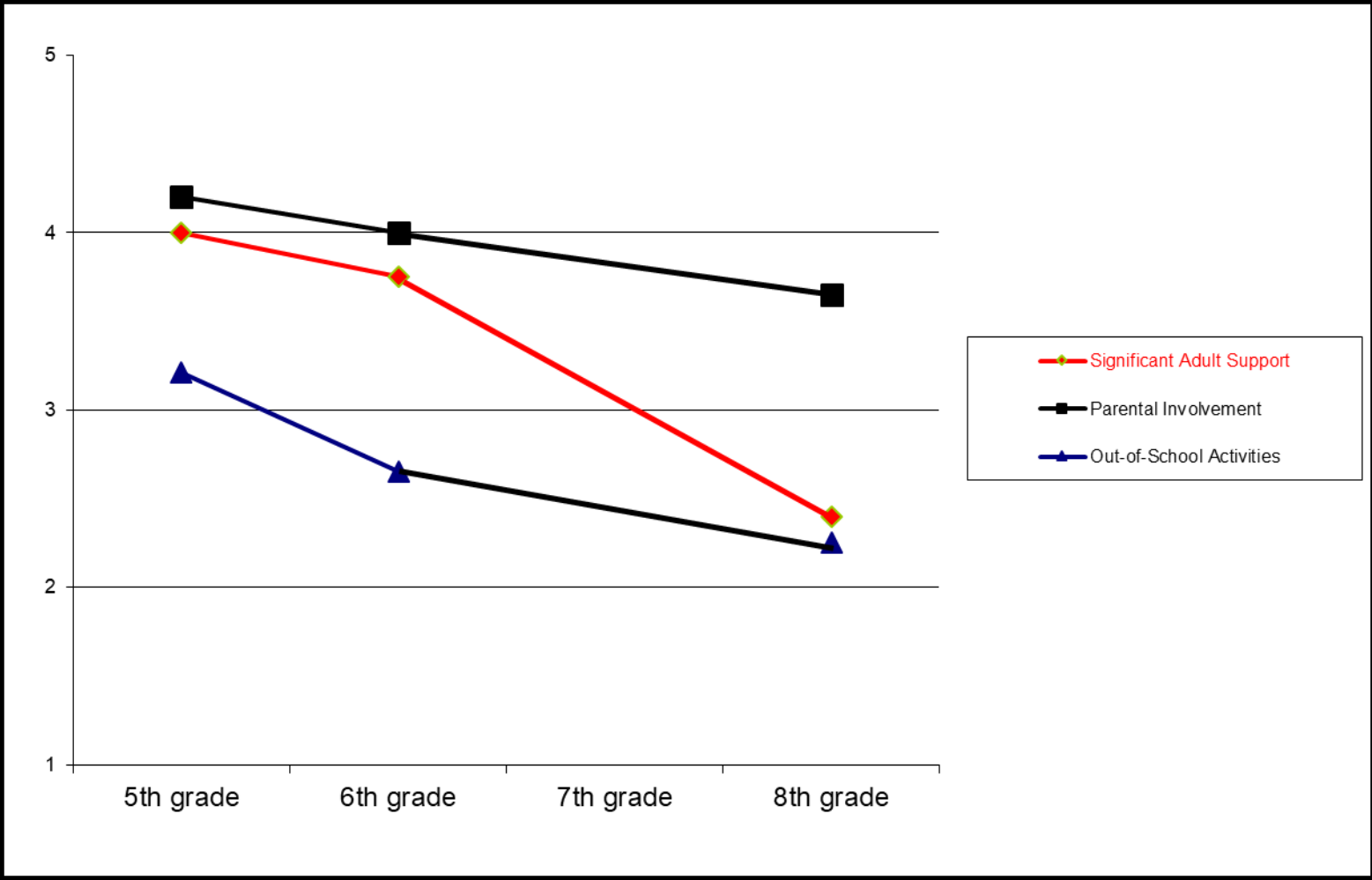
All the Time

Almost All of the Time

Occasionally

Almost Never

Never



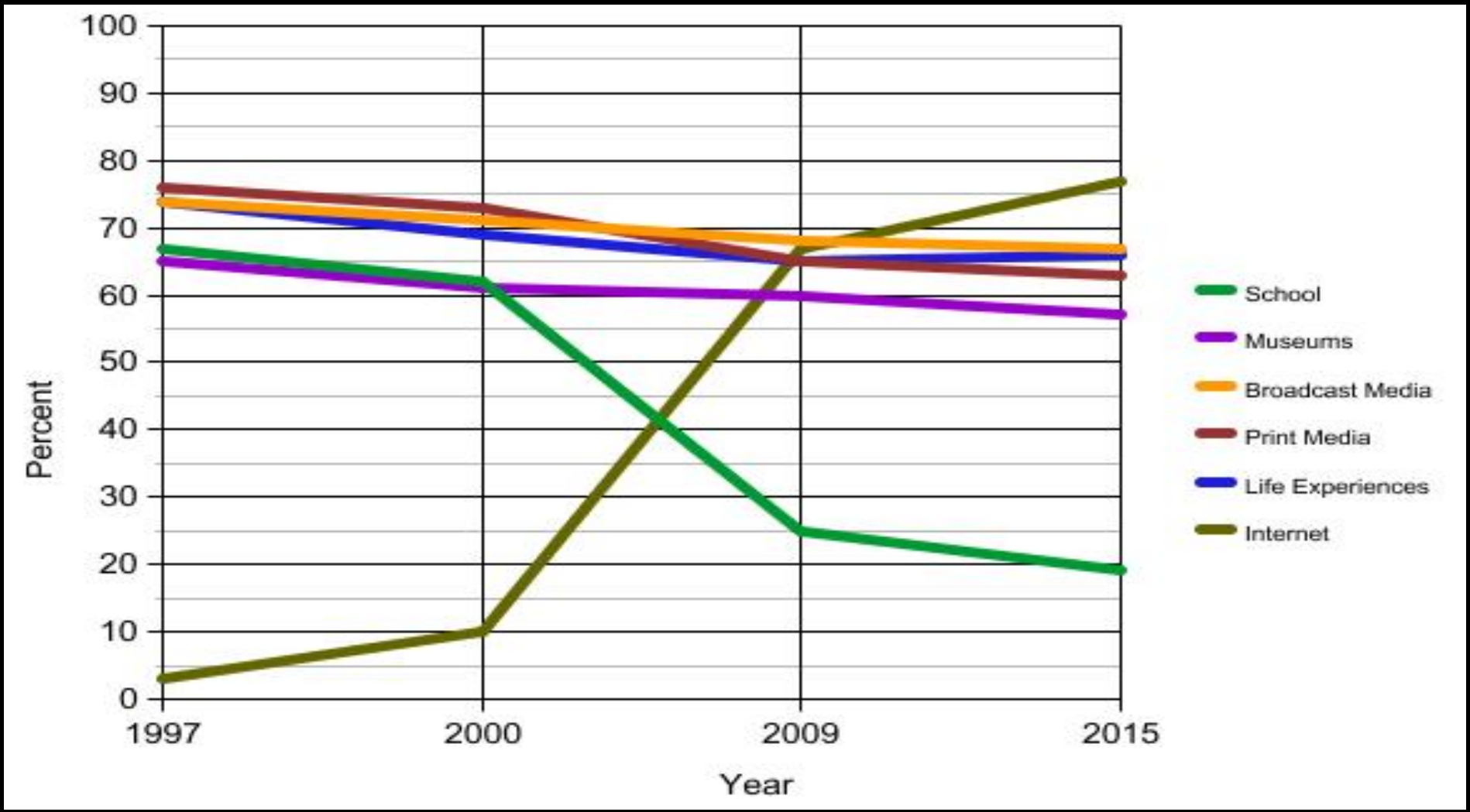
How Important are Informal Science Education Institutions?

- There is broad public agreement that public should be science knowledgeable (literate).
- Also broad agreement that people learn both in and out-of-school.
- No agreement on the relative contributions of the various sources of science learning.

4 recent studies help to clarify this issue

L.A. Science Education Research (LASER) Project

Sources for Science Learning



Falk, Brooks & Amin (2001); Falk, Storksdieck & Dierking (2007);
Falk & Needham (2011); Falk, Pattison, Meier, Bibas & Livingston (2017)

ISCIS – International Science Center Impact Study

Falk, Dierking, Swanger, Staus, Back, Barriault, Catalao, Chambers, Chew, Dahl, Falla, Gorecki, Lau, Lloyd, Martin, Santer, Singer, Solli, Trepanier, Tyystjärvi & Verheyden (2016)

Institution	Country	Adult	Youth	Total
Canada Sci. & Tech. Museum	Canada	250	250	500
Heureka	Finland	379	336	715
International Centre for Life	UK	424	384	808
Maloka	Colombia	406	469	875
Frost Museum of Science	USA	256	253	509
MIDE	Mexico	384	384	768
Nat. Museum Natural Science	Taiwan	521	590	1111
National Museum Sci. & Tech.	Sweden	287	319	606
Ontario Science Centre	Canada	250	250	500
Ciência Viva	Portugal	321	319	640
Questacon	Australia	381	278	659
Science Centre Singapore	Singapore	412	333	745
Science North	Canada	385	322	707
Technopolis	Belgium	388	382	770
TELUS Spark	Canada	392	253	645
Universeum	Sweden	258	308	566
VilVite	Norway	395	362	757
TOTAL		**6,089**	**5,792**	**11,881**

ISCIS Results:

Youth (14-15 yrs.) & Adults (18+ yrs.) who visited science center had significantly higher:

- Knowledge & Understanding of Science & Technology
- Interest in & Engagement with Science & Tech. In & Out of School
- Participation in Sci. & Tech.-related Careers & Hobbies
- Perceived Confidence in Science & Technology

Sci. & Tech. Knowledge X Education, Income & Interest X Visit/Not Visit

	No Visit	Visit	F-value	p-value	Eta
> BA degree	2.54	2.72	206.67	0.000	.31
< BA degree	2.25	2.48			
> Median Income	2.39	2.62	107.41	0.000	.24
< Median Income	2.29	2.55			
Really Like Sci. & Tech.	2.61	2.81	488.89	< .001	.56
Like Sci. & Tech.	2.27	2.41			
Dislike Sci. & Tech.	1.86	2.12			

Long-Term Science Learning

Relative Contribution of Science Learning Resources in L.A. (n = 1,018)

Falk & Needham, 2013

Contribution of All Resources:

Regression Analysis Predicting Science Knowledge

	β	*p*-value
Books, magazines, newspapers not school	.181	< .001
Male	.157	< .001
Use the Internet to learn about science/tech	.151	< .001
Income (over yearly median)	.116	< .001
Education (highest level completed)	.114	< .001
Work or on-the-job training	.113	< .001
Childhood Read books, magazines, or newspapers	.112	< .001
Current occupation science/tech related	.109	< .001

Regression Analysis Predicting Science Knowledge

	R^2	X^2-value	p-value
Formal Education Model	**0.17**	**133.08**	**< .001**
Childhood Free-Choice Learn. Model	**0.17**	**122.61**	**< .001**
Workplace Model	**0.20**	**152.61**	**< .001**
Privilege Model	**0.23**	**152.95**	**< .001**
Adult Free-Choice Learning Model	**0.39**	**323.95**	**< .001**

Overall Model: $R^2 = 0.51$, $X^2 = 369.43$, $p < .001$

MISCES – Multi-Institutional Science Center Effects Study

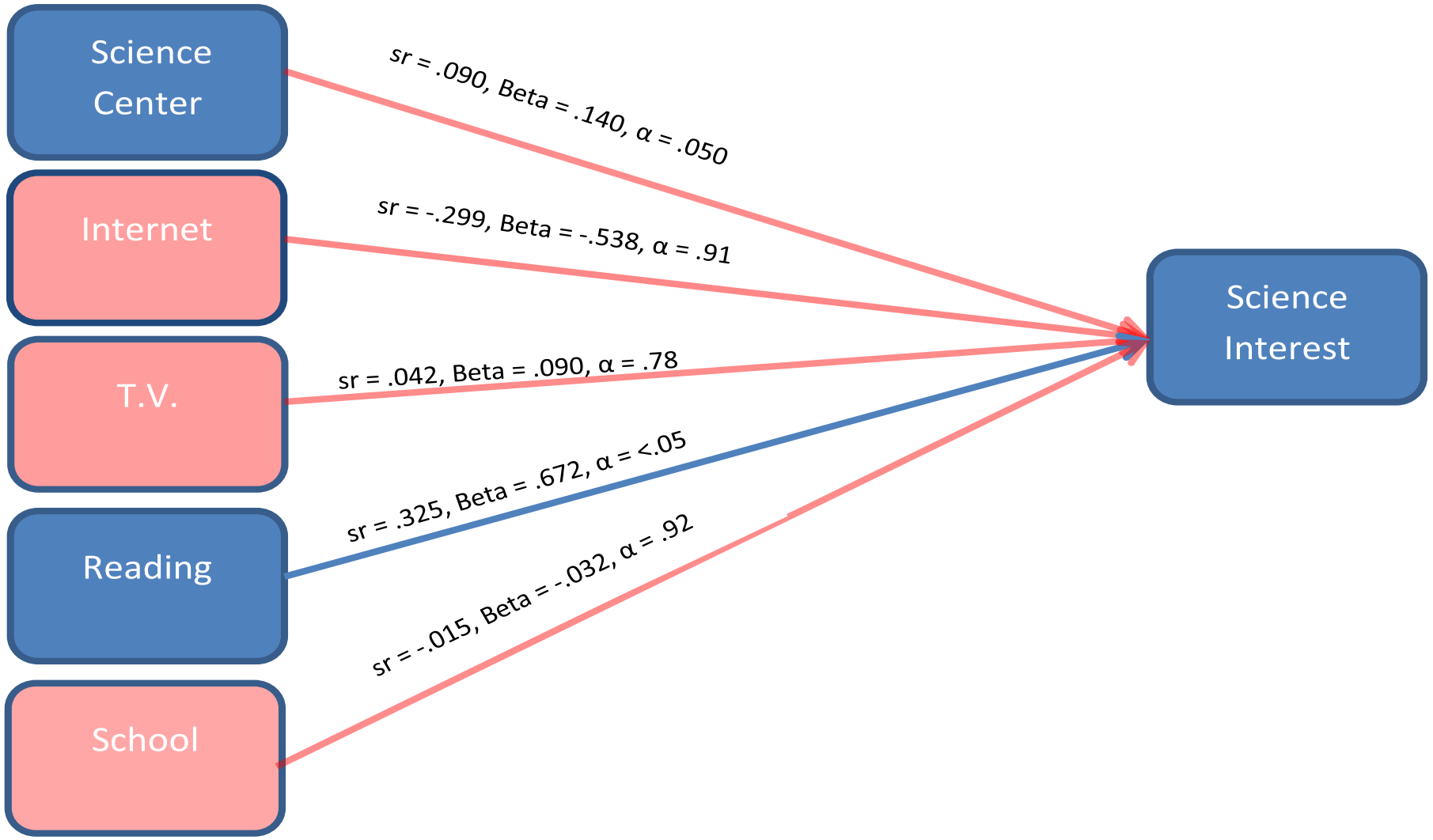
Falk, Pattison, Meier, Bibas & Livingston, 2017

Random sample of Youth (n = 1,450) & Adults (n = 3,001) in L.A., Philadelphia and Phoenix

What is relationship between youth's & adult's current interest in science and their perceptions of their past and current experiences with 5 key science education modes:

- Attending SCIENCE CLASSES in school
- Visiting a SCIENCE CENTER (outside of school)
- Using the INTERNET for science (not for school)
- Watching science TELEVISION (at home)
- Reading science-related BOOKS & MAGAZINES (not for school)

Youth Multiple Regression of Past Science Experiences on Current Science Interest



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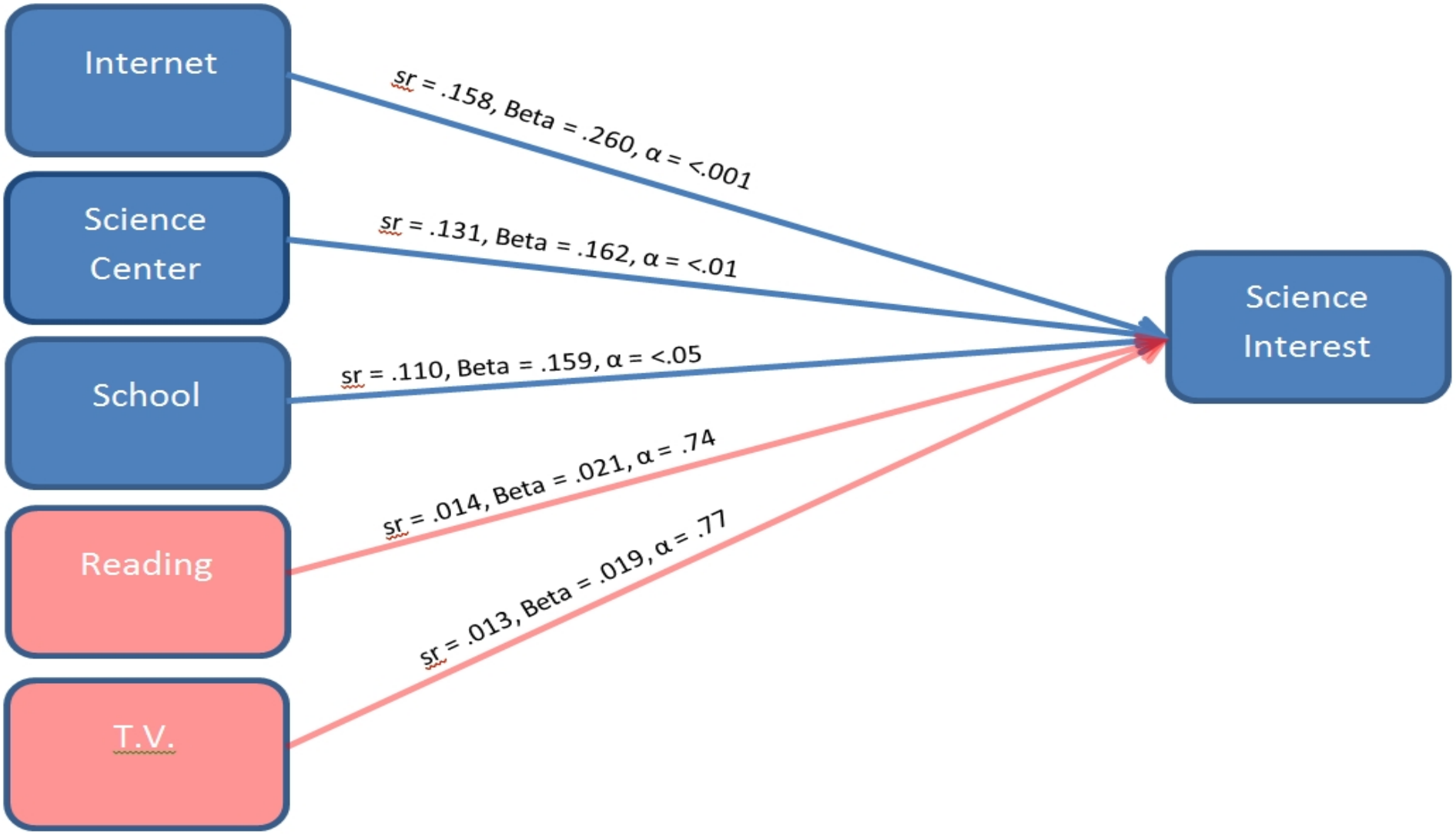
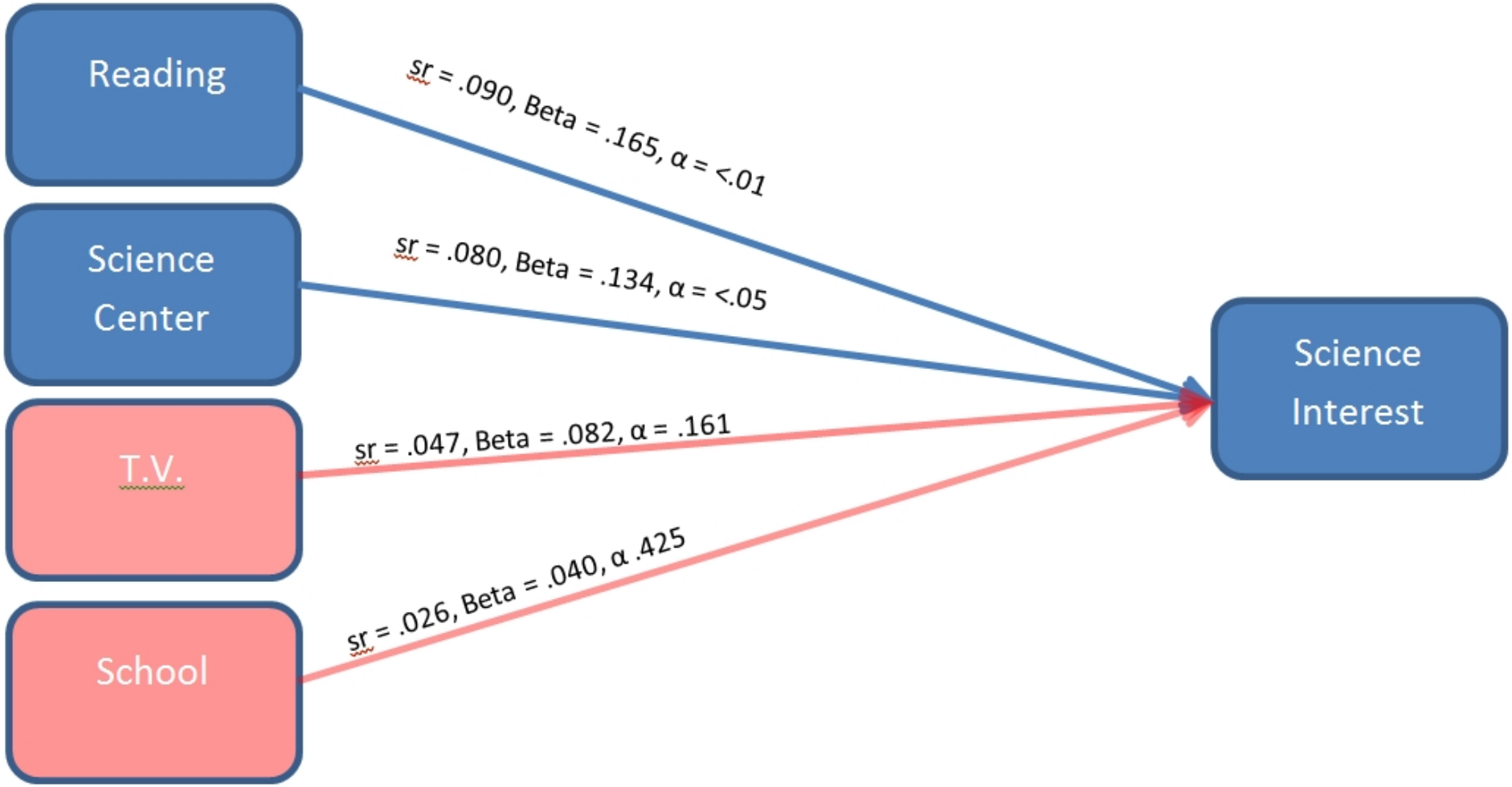
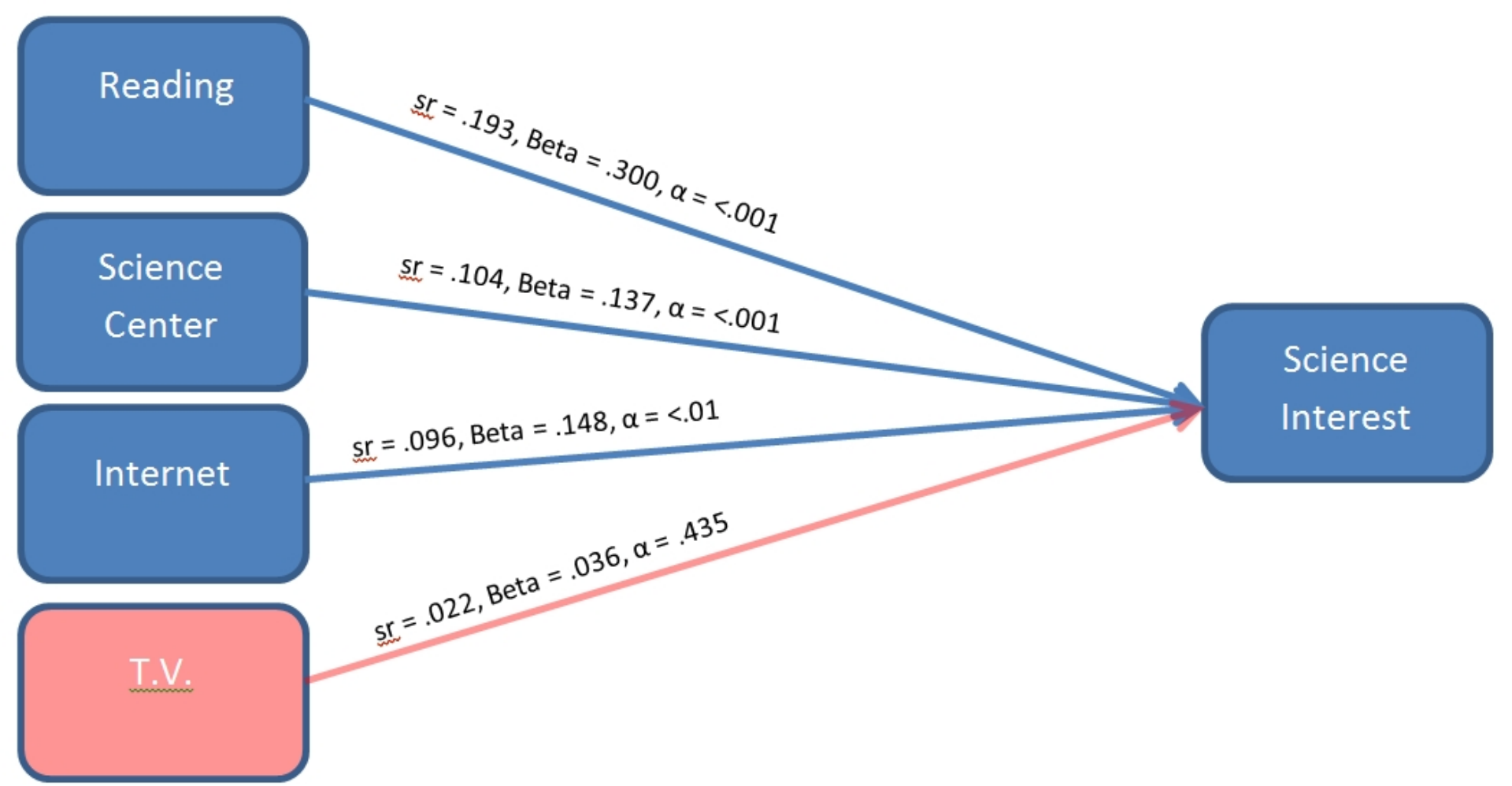


Adult Multiple Regression of Past Science Experiences on Current Science Interest



Adult Multiple Regression of Current Science Experiences on Current Science Interest



Key Research Take-Aways:

- People depend upon many resources to learn science; learning is on-going and cumulative.
- The main reason people learn science, including children, is to satisfy curiosity and to fulfill personal needs and interests.
- Informal science education institutions play a central role in supporting a science-informed and literate society.

What are the Implications for Informal Science Education Institutions in Texas?

Texas ISEs Should:

- Be places that inspire the next generation of scientists and technologists and science-interested and engaged citizens.
- Assert themselves as LEADERS in the area of 21st Century Science Learning – Locally, Regionally & Nationally.

But to be successful in this leadership role, ISEs need to take a more systemic approach to science learning

To be effective in the 21st Century science education needs to be:

- ***Customized*** **to meet unique personal interests & needs of learners from novice to master**
- ***Connected*** **to community & family in ways that allow learners to see its relevance in their lives**
- ***Coordinated*** **to maximize synergies between various players in the learning ecosystem**

What Needs to Change?

- Need to redefine the goal of Texas science education to insuring that learners of all ages and backgrounds have lifelong support to pursue their own personal science learning needs & interests.
- Need to re-envision “Public Education” in Texas to mean more than schools; Public Education is an entire system of 10,000s of institutions working together synergistically to support learning.
- Need to revise educational policy in Texas to reflect the fact that informal experiences are JUST as VITAL to public science learning as schools.

THANK YOU

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