THE IMPACT OF SCIENCE CENTRES

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Director's Cut

Not an academic literature review, though the references of the references listed probably contain the bulk of the literature on impact of museums/science centres.

A selection of studies/sources that produced useful information, i.e. results that could be used to make your case as a science centre.

Director's viewpoint often pragmatic: can a particular stand be defended/supported by scientific evidence?

World Wide Science Centre Movement

Today, there are more than 3000 science centres in the world. They are visited by more than 300 million visitors each year.

25 years ago, only ten percent of these institutions existed. We are in the midst of a global movement that continues to expand. It is hardly just because science centres are nice: they are perceived to perform a service to their communities.

Persson (2000) indicated global growth estimates of numbers of institutions at 5 % per year and attendance at 2 % per year in the 1990s. Growth has continued.


KESKO

We Measure Impact

Science centres and museums individually measure impact on visitors and society.

E.g., the KPIs for Heureka reported by Persson (2011) measure visitors and their satisfaction, economic efficiency, content and its renewal, and provision of education.

Jacobsen (2014) lists measurable activities by different museums and science centres for educational (e.g. offering teacher workshops), economic (e.g. contributing to tourism) and social purposes (e.g. celebrating local identity and community pride).

1025 Existing Indicators

Jacobsen (in preparation) developed a system to look at 1025 existing qualitative and quantitative indicators used by museums or in museum studies. These contribute to public, private, personal and institutional values. The sets identified are:

Broadening participation, Preserving heritage, Strengthening social capital, Enhancing public knowledge, Serving the educational system, Advancing social change, Communicating public identity & image, Contributing to the economy, Delivering corporate community services, Enabling personal growth, Offering personal respite, Welcoming personal leisure, Helping museum operations, Building museum capital.

Structure of Talk

A review of impact studies related to

- Different aspects of learning
- Contributions to the local economy
- Involvement in community development


MOUNTAIN
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Learning and Making Meaning

Learning to be regarded as “a personally constructed, highly idiosyncratic, lifelong process of making meaning.”

“Most of what we learn in our lives we learn not because we have to, but because we choose to”.

(Falk et al. 2007)

Contextual Model of Learning

Contextual Model of Learning in Museums:

The personal context: a variety of experience and knowledge

The sociocultural context: culture and social interaction

The physical context: architecture, design, ambience, both physical and virtual

(Falk & Dierking 2013)

Visitor Agendas

People come for different reasons: visitor identities

- Explorers: curiosity
- Facilitators: socially motivated
- Professionals/Hobbyists: professional passion
- Experience Seekers: reputation of museum
- Rechargers: contemplative experience

(Falk 2009)

Learning Happens in Many Places

Falk & Dierking (2010):

”Average Americans spend less than 5 % of their life in school classrooms; and an ever growing body of evidence demonstrates that most science is learned outside of school.”

This is probably true for many other countries, as well.

You Learn from Many Sources

Falk & Needham (2011):

”An individual’s understanding of the physics of flight, for example, might represent the cumulative experiences of completing a classroom assignment on Bernoulli’s principle, reading a book on the Wright brothers, visiting a science center exhibit on lift and drag, and watching a television program on birds. All of these experiences are combined, often seamlessly, to construct a personal understanding of flight; no one source is sufficient to create understanding, nor one single institution solely responsible.”

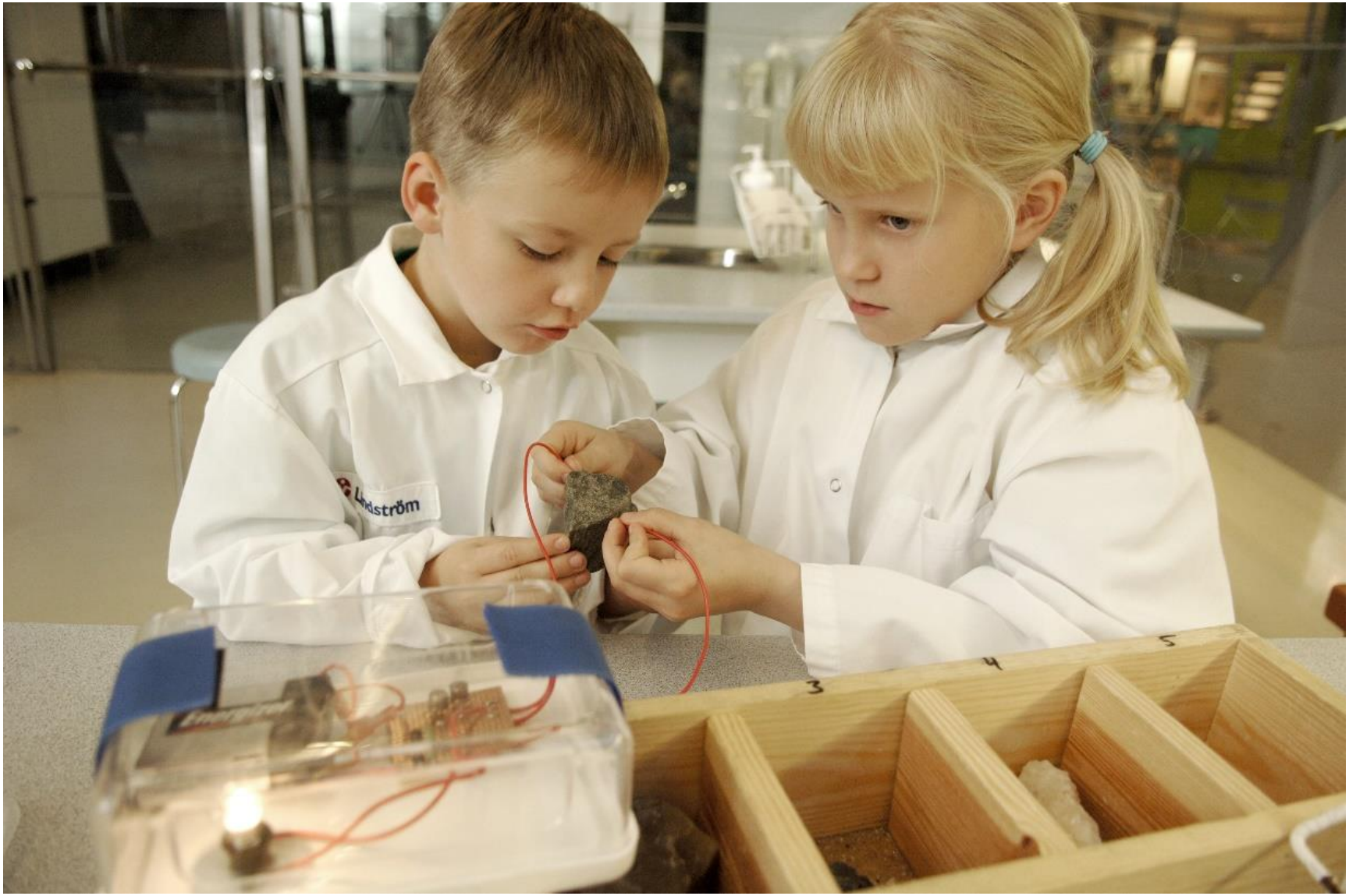
Sources of Informal Learning

Sources of information for learning about science and technology:

- school,
- books and printed matter,
- life experiences,
- television,
- work,
- museums, zoos and science centres,
- internet,
- friends or family,
- radio.

Museums were used to some extent by 38.2 %, a lot by 22.8 % of the respondents (in 2000).

(Falk et al 2007)



Learning in Science Centres

There is a vast literature about learning in museums and science centres.

A review by Bitgood et al. (1994) of 150 articles showed that there are intellectual, emotional and physical impacts of informal learning in science museums. Traditional tools of experimental design are often inappropriate for studying informal settings.

George Hein's classic monograph Learning in the museum (1998): learning occurs!

Learning in Science Centres (2)

The review by Garnett (2002), commissioned by a group of 13 science centres around the world, summarized 180 reports on impact by science centres.

The review indicated that 87 % of these reports and studies related to personal, i.e. learning and educational, impact.

Of the personal impact, 54 % related to science learning, 18 % to attitudes, 14 % to enjoyment and 7 % to career choice.

Learning in Science Centres (3)

The authoritative and extensive review on informal science learning provided by the U.S. National Research Council (2009) concludes that there is compelling evidence of learning in designed settings, such as science centres:

- There is evidence of excitement and positive emotional responses.
- There is clear evidence of learning science content.
- There is evidence of engagement and reflection.
- There is evidence of integrating science learning with values and identity.

Learning in Science Centres (4)

The report prepared by Frontier Economics (2009) for the British government contains a literature review supporting similar conclusions:

- Science centres may improve people's understanding of scientific issues,
- change people's attitudes, and
- encourage children to pursue careers in science.

Visitor Behaviour

Barriault and Pearson (2010) developed a visitor engagement model at Science North, Canada, by observing visitors' behaviour at specific exhibits.

The behaviours can be grouped in three categories that reflect increasing levels of engagement and learning: initiation, transition and breakthrough.

In Science North, transition is typically reached by 20-80 % of the visitors and breakthrough by 20-60 %.

This provides direct evidence of learning occurring in the exhibition halls.

Creating Memories

“Museum experiences, both exhibitions and programs, are remarkably memorable. The vast majority of visitors to museums create durable memories of some aspect of their experience.

The persistence of museum memories is one indicator that museum experiences promote learning.”

(Falk & Dierking 2013)


4.

Remembering

In his study on long-term effects of visits to the Launch Pad at the Science Museum in London, Stevenson (1991) observed that visitors were able to recall single exhibits 6 months after the visit. 26 % of the answers contained reflections on the phenomena observed and 14 % related to feelings.

Medved & Oakley (2000) looked at how adults remembered exhibits after a science centre visit and observed that one third of the persons interviewed were able to relate the exhibit content to everyday occurrences.

Bamberger & Tal (2008) studied students visiting a museum in Israel. After 16 months the students retained details of the experience and indicated a contribution by the visit to their knowledge.

Perspective and Awareness

Falk et al. (2004) focused on the types of short- and long-term learning that resulted from the use of interactives in two Australian institutions.

Short-term outcomes: knowledge and skills, motivation and interests.

Long-term outcomes: perspective and awareness, social learning.

The major learning outcome over time was a positive shift in visitors' perspective and awareness.

The vast majority (73 %) of visitors could articulate an outcome after several months of elapsed time. Most of them reported that they gained new perspective and awareness on science.

Reflection and Attitudes

British studies (Frontier Economics 2009) interviewing science centre visitors report that

- 59 % learnt more than expected
- 43 % evoked thoughts about science
- 12 % reported change of attitudes towards science

International Science Centre Impact Study

In an extensive international study on the impact of science centres, Falk et al. (2014) collected data from 17 centres in 13 countries, interviewing 13 558 persons.

The results support the contention that individuals who used science centres were significantly more likely to be science and technology literate and engaged citizens.

The more frequent, the longer and the more recent the science centre experience, the stronger the correlation for all outcomes.

ISCIS (2)

The study shows clear correlations between science centre visits and

- science and technology knowledge and understanding
- interest and curiosity in science and technology
- engagement with science and technology related activities
- confidence in science and technology.

Cognitive Effects

Salmi (2003) conducted, inter alia, knowledge tests on groups of students visiting and not visiting science centres. He found clear positive cognitive learning effects from using science centre exhibits.

Miller (2004) found that the informal learning resources (which included science museums and science centres) contributed to civic scientific literacy in the United States.

Falk & Needham (2011) studied visitors to the California Science Center in Los Angeles during a decade after its opening in 1998. Results suggest that the science centre has had an important impact on the science literacy of greater Los Angeles. Self-report data by visitors indicate that the centre strongly influenced their understanding of science and technology.

Cognitive Effects (2)

Thuneberg et al. (2014) studied 565 students participating in the travelling Science Circus of Heureka and found that the interactive exhibition visit increased knowledge regardless of students' school achievement. It also leveled gender differences in learning.

At the Field Museum, Hanko et al. (2015) found that people value the museum as an opportunity for learning –but not only about the museum content. It is about new ways of thinking and asking questions they did not know they had.

Controversial Finding?

In contrast to the overwhelming majority of findings in the literature, and in contrast to his previous work, Miller (2010) reported no contribution by science museums to civic scientific literacy. His concept of literacy stresses knowledge of arbitrarily chosen facts (as determined by multiple-choice tests) and fact-finding, while museums are strong in engagement, motivation and the affective domain. His mathematical model contains elements that warrant further studies, as the results seem partly contradictory.

Motivation

As Salmi (2003) points out, a science centre visit is short. Motivation becomes important. In his studies on motivation, he found that science centre visits had a positive effect on the motivation of students in all age groups. Results were most positive among primary school pupils.

School students having intrinsic motivation gained both better cognitive results and tended to apply deep-learning strategies in the learning process.

Gifted students seemed to get more motivated than others during the science centre visits. However, students with learning difficulties also got more motivated.

Interest in Science

Interest in science is generally generated at an early age, before Middle School (Maltese & Tai 2009).

In an American survey by the National Science Foundation, people with science-related careers reported visits to museums and science centres as their most memorable informal science experiences as children (Sladek 1998).

Interest and Careers

The evaluation of the Informal Science Education Program of the U.S. National Science Foundation (Sladek 1998) shows that

- Of people with science careers, 85-92.9 % indicated as their most memorable informal education activity from their childhood visits to planetariums, aquariums, zoos, science museums or natural history museums.

- Among sources of ideas learned in youth and still used, people with science careers listed visits to science centres and museums as the most frequent (51.6 %).

- Among early education activities that initiated connections with school, science centres and exhibits top the list (50 %).

Science Centres and Career Choices

Coventry (1997), working in Perth, Western Australia, and Salmi (2003), working in Finland, were able to show a relation between science careers and science centres. Both surveyed university students, and both showed that 80 % of students in natural sciences had visited science centres, whereas in Perth only 64 % of the students in other subjects had. In Finland, a factorial analysis indicated the involvement of the Finnish science centre Heureka in patterns influencing career choices.

The results show that informal learning resources such as science centres have an effect on the career choices by university students.

Collective Evidence

The collective evidence strongly indicates that science centres

- strengthen science learning
- enhance interest in science
- strengthen motivation to learn science
- affect attitudes towards science and technology positively
- increase confidence in science
- influence career choices by young people.

Science centre visits may result in long-lasting memories, indicating a strong personal impact on visitors.

Local Prosperity

The review by Groves (2005), commissioned by an international group of 13 centres, indicates that science centres have a measurable economic impact on their communities.

Primary impact can be calculated from primary data (the expenditure of the science centre, salaries paid, number of visitors and their spending on the visit). Total economic impact seems to be 1.5 to 1.7 times the primary impact. Multipliers have been criticized, however, as they seem to overestimate the impact.

Science centres are part of cultural tourism and thus the tourism industry.

Economic Impact

Americans for the Arts have since 2002 launched major studies on the economic impact of the American non-profit cultural sector (www.americansforthearts.org).

The latest study containing data from 2010 estimate the economic volume of the non-profit culture sector of 135 billion USD. It employs 4.13 million employees. The total public arts allocation in the US is about 4 billion USD.

Science centres are included in this material, but the results pertain to the whole cultural sector.

Economic Impact (2)

Americans for the Arts have on their website a simple calculator to estimate the economic impact of an institution:

http://www.americansforthearts.org/information_services/research/services/economic_impact/iv/calculator.html

For Heureka in 2012, the Finnish Science Centre, the calculator estimates a primary economic impact of 17.9 M€ in the Helsinki Metropolitan Region (Heureka budget ca 10 M€, annual attendance 300 000, metropolitan population 1 million). The public subsidies of Heureka amount to 5,5 M€.

Piekkola et al. (2013) Finnish museum goers use on the average € 49.40 for a museum visit. Thus calculated, Heureka's direct impact is 14.8 M€.

Average Audience Spending

www.americansforthearts.org

Average spending per cultural event, USA, 2010

Meals, snacks, refreshment	USD 13.14
Local ground transportation	USD 2.65
Overnight lodging	USD 3.51
Gifts and souvenirs	USD 2.74
Clothing and accessories	USD 1.31
Other	USD 1.21
Total	USD 24.60

Global Economic Impact

If we use the Americans for the Arts average spending figure (USD 24.60 per visit), the world-wide economic impact of the science centre movement (300 million visitors) is 7.4 billion USD.

If we use the Finnish figure from the 2013 survey (USD 55.80), the global impact of the science centre movement amounts to 16.8 billion USD.

Thus, the order of magnitude of the global economic impact of science centres lies in the range **7-17 billion USD.**

Cost Effectivness

A British survey (Frontier Economics 2009) compared unit costs of British science centres to other informal science programmes.

An hour in science centers cost GBP 2.7-5.9 per visitor, as in 7 other informal science programmes the cost were GBP 0.7-11.0 (only two of the programmes had cost under 2.7 GBP).

Urban development

Science centres are part of cultural tourism and the educational offerings of a society. In urban redevelopment schemes, they often form an integral part.

In Finland, Heureka was built on a piece of derelict land, which became a park. After Heureka was established, the National Board of Forests and the Central Criminal Police of Finland moved their headquarters to the area. A major urban development has occurred in the area, with new housing and office projects. This development continues.

The ultimate example of urban redevelopment: Science City in Kolkata

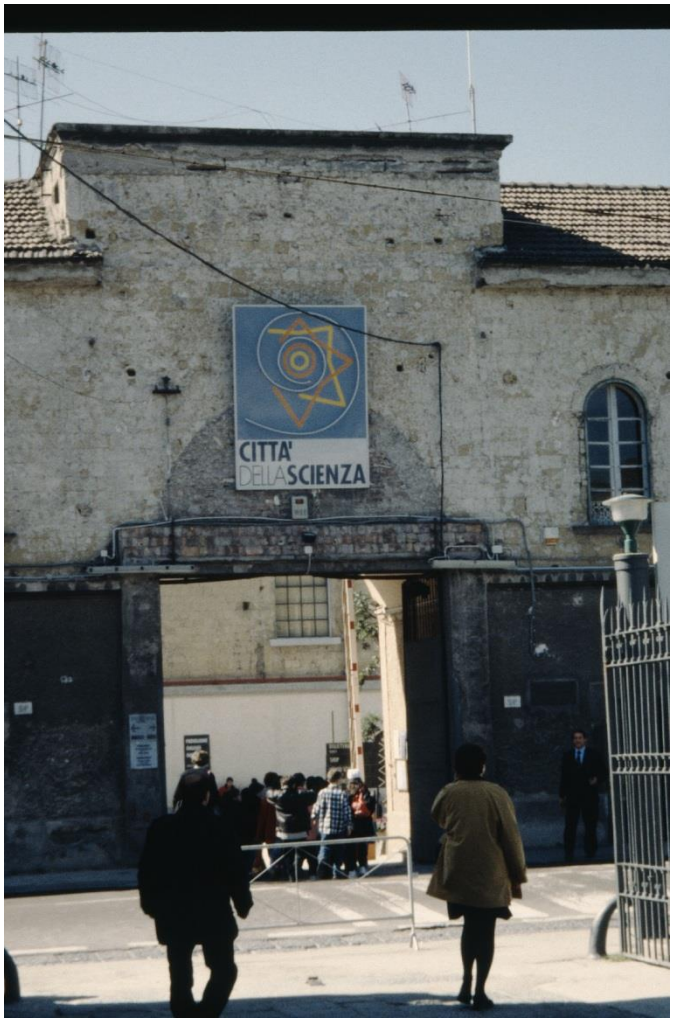
Science City was built on the garbage dump of Kolkata

Today, it is a vibrant place attracting more than 1.5 million visitors every year

The first cultural institution in the redevelopment of the Baltimore Inner Harbor was Maryland Science Center.

Techniquest was the first cultural institution in the development of Cardiff Harbour, now hosting e.g. the Welsh National Opera.

Citta della Scienza inaugurated the development of a derelict industrial zone of Naples



The Mechelen Declaration

At the Science Centre World Summit in Mechelen in 2014, a declaration was approved: Public Engagement for a Better World.

Of seven declared goals, the literature proves that science centres contribute at least to five:

- Engagement with local communities, gender issues in learning
- Increased awareness of and confidence in science
- Attention of decision-makers to science engagement
- Better methods of learning science
- Influencing attitudes, empowering people

Conclusions

Scientific and empirical evidence shows beyond doubt that science centres

- Enhance learning
- Enhance local prosperity
- Contribute to urban development.

But is this enough? Are science centres considered Big League even in the education sector? Are science centres considered really necessary? If not, what needs to be done?

We need a strategy to position science centres in the world as essential players in education, science and technology.

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