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Broadening nanotechnology's impact on development

Koen Beumer

Discussions about nanotechnology and development focus on applications that directly address the needs of the world's poor. Nanotechnology can certainly make an impact in the fight against global poverty, but we need to broaden our imagination.

It is commonly believed that nanotechnology can help solve the problems associated with severe poverty in developing countries through applications that directly address the needs of the poor. Nanotechnology may, for instance, enable the creation of cheap water filters that do not require electricity, solar cells that can be printed on sheets of paper, and improved drug delivery systems for neglected diseases — applications with obvious benefits for people deprived of a steady supply of clean water, electricity, and health services.

But we should not take this view of the relation between nanotechnology and global poverty for granted. A look at the genealogy of this connection can help us to see that nanotechnology can contribute to the fight against global poverty in other ways too.

Addressing the nano-divide

The connection between nanotechnology and development issues is often discussed under the banner 'nano-divide'. It refers to the concern that nanotechnology increases the gap between the rich and the poor because its benefits would only be experienced in the wealthy places of the world.

The term nano-divide first came into circulation in discussions about the societal impact of nanotechnology following the launch of the American National Nanotechnology Initiative in 2000^{1–6}. Initially, a wide variety of issues were shared under this banner (Table 1). Concerns were raised about anything from intellectual property rights to the replacement of jobs, and from trade agreements to the local contexts where nanotechnology applications had to work^{3,7–9}.

In the debate that followed, however, the focus was quickly narrowed down.

Table 1 | Different nano-divides³⁴.

Nano-divide	Description
Access nano-divide	Beneficial nanotechnologies may not be accessible to the world's poor.
Profit nano-divide	Economic profits from nanotechnologies may land exclusively in developed countries, thereby exacerbating global inequalities.
Benefit nano-divide	Nanotechnologies may be primarily developed to answer the needs of wealthy consumers, thereby failing to address the needs of the poor.
Control nano-divide	The control over nanotechnologies may be used to dictate the terms of their use, thereby deepening unequal power relations.

A core contribution to the debate was made by a group of researchers from the University of Toronto Joint Centre for Bioethics (henceforth 'the Toronto group'), who sought to address concerns over a growing nano-divide by identifying those nanotechnologies that would be most beneficial for development.

To this end, the Toronto group conducted a Delphi study¹⁰. They asked a group of nanotechnology experts from both developed and developing countries to identify areas of application where nanotechnologies could be beneficial for development. The result was a table ranking nanotechnologies that experts considered most relevant for development, hence carving out a number of poverty-relevant applications from the wide variety of uses that nanotechnology may have. Benefits to developing countries were especially expected in the fields of energy (storage, production and conversion), agricultural productivity enhancement, water treatment and remediation, and disease diagnosis and screening¹⁰.

The Delphi study was published in *PLoS Medicine* in 2005¹⁰ and soon made a significant impact on the discourse on nanotechnology and development. Already in the same year the United Nations Millennium Development Goals

task force on science, technology and innovation used these insights to claim that nanotechnologies "hold great promise for the Goals"¹¹. In the following years, the article¹⁰ became the core reference for the claim that nanotechnology can benefit developing countries and was widely drawn on by governments and civil society organizations in both developing and developed countries^{12–16}.

This narrative must be understood within the context of the renewed interest in the role of new technologies for development. Since the late 1990s, a breadth of international organizations has highlighted the positive contributions that new technologies may bring to development^{12,14,17,18}. Rather than considering developing countries as passive recipients of old technologies, importance was put on the developmental benefits of new technologies such as biotechnology and information and communication technologies (ICT). Akin to the situation where apprehensions about the digital divide led to an emphasis on the positive contributions that ICT may bring to the world's poor, as captured by the concept ICT4dev¹⁹, the Delphi study also translated concerns over a growing nano-divide into an opportunity for nanotechnology to benefit developing countries — a discourse that can hence be characterized as 'nano4dev'.

Nano4dev

There should be no doubt about the importance of recognizing the potential and real impact of nanotechnology on the world's poor. Yet the attention on applications that directly address the needs of the poor is unnecessarily limited. A closer look at three aspects of the Delphi study's research design can offer insights into how to move forward.

First, the emphasis is on the 'benefits' of nanotechnology for development. In an earlier publication, researchers from the Toronto group had argued that overt attention to issues of risk could discourage developing countries from engaging with nanotechnology²⁰. Thus, in the Delphi study they only described those nanotechnologies most likely to benefit developing countries¹⁰ and do not mention those that could be harmful.

This arguably leaves out a great deal of possibly significant ways in which nanotechnology may affect the world's poor. Nanotechnology, like any technology, can have both positive and negative consequences, as has repeatedly been pointed out. For instance, environmental risk modelling has demonstrated that the presence of nanoparticles in waste streams poses additional environmental and health risks in developing countries where waste collection systems are inefficient and know-how about waste management of nanoproducts is limited²¹. Social scientists have pointed out that depending on how the technology is governed, nanotechnology may exacerbate social divisions, for instance between men and women²² and between various racial groups²³. And research into the economic implications of nanotechnology has pointed out that the potential use of carbon nanotubes to replace expensive highly conductive metals in electronics may have adverse effects for developing countries whose economies are dependent on the export of such metals, for example South Africa (gold), Peru (silver) and Chile (copper)^{24,25}. Studies such as these, however, are few and far between.

Second, the focus is on applications that 'directly' address the needs of the poor. Although the Delphi study mentioned indirect effects on developing countries through capacity building and income generation as one criteria for assessing the benefits of nanotechnology, the outcomes of the study do not show the results of such indirect benefits. The experts were asked to limit their assessment to nanotechnologies in the areas of water, agriculture, nutrition, health, and energy, and the assessment criteria included the questions whether the technology addresses the most pressing

needs and how much difference the technology can make¹⁰. As a result, the priority areas listed in the Delphi study focus on technologies that are beneficial to the poor by directly addressing their basic needs.

While nanotechnologies can have a direct impact on the world's poor, there are also many other ways such technologies can benefit development. One can imagine scenarios in which factories producing nanomaterials may create new jobs²⁶; nanotechnology applications may help to improve existing infrastructures for water and electricity that are not functioning optimally; the creation of high-skilled jobs in nanotechnology may curtail brain drain; nanotechnology products using minerals mostly found in developing countries may boost domestic industries; and increasing tax revenues generated from nanotechnology-enabled economic growth may trickle down to the poor in the form of governmental intervention measures. Few of these scenarios have been systematically investigated^{27,28}, but even this cursory glance at some of the indirect ways in which nanotechnology may benefit developing countries suggests that the emphasis on technologies that directly address the needs of the poor is lamentably limited.

A third limitation of the Delphi study is that it only relied on the expertise of scientists. There is a methodological argument to make here: the founders of the Delphi method have pointed out the danger of including only engineers and scientists as they have been consistently found to be too optimistic in the short term while underestimating non-technical difficulties²⁹. But the more important point is that by putting forward nanotechnology experts as the only relevant authorities on the relation between nanotechnology and development, the Delphi study paves the way for development to be seen as a problem that can be solved by means of technologies alone.

There are clear shortcomings to this view. Development is a complex and multidimensional phenomenon and can by no means be reduced to a problem that is exclusively technological³⁰. Insights from fields such as innovation studies and science and technology studies have long established that for technologies to successfully solve societal problems, both technological and societal changes are required^{31–33}. Subsequently, for nanotechnology to contribute to development, expertise is required about both technological and societal change. This not only implies that different kinds

of expertise should be included, such as development specialists and science policy experts, it also urges us to ask different kinds of questions. Rather than asking what nanotechnologies can benefit the world's poor, the question that is most pressing for making nanotechnology relevant for the world's poor is what socio-technical configurations are required for development to occur.

Reconstructing promises

While the nano4dev discourse has done important work by articulating one way in which nanotechnology may contribute to development, the preceding discussion of its limitations suggests that developing poverty-relevant applications is only one of the many ways in which nanotechnology may have an impact on the world's poor. This discourse has drawn the attention of funding organizations and researchers that are now putting efforts into realizing this expectation, creating beneficial technologies that otherwise may not have been developed. Yet by sticking to this single perspective, we insufficiently acknowledge the multi-faceted impact that nanotechnology may have on the world's poor.

The critical discussion of the nano4dev discourse has identified three starting points for widening our perspective. First, not only should the possible benefits of nanotechnology be considered but so should the potential negative impacts that nanotechnology may have on development, including risks to human health and the environment and changes in material demands. Second, rather than merely focusing on applications that directly address the needs of the poor, a variety of indirect benefits should be taken into consideration as well. And third, efforts to articulate the impact of nanotechnology on development should not only include the voices of scientists and engineers but of various other experts as well, so as to reflect the technological and societal changes required for nanotechnology to make an impact in the fight against global poverty.

By exclusively focusing on applications that directly address the needs of the poor, we risk losing sight of the various steps that can be taken not only to remedy potentially negative impacts but also to harness the full potential of nanotechnology for development. □

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