News & views

Sociology

Monitoring global education inequality

Monica Grant

Tools have been developed to project inequalities in education around the world to 2030. They reveal that overall inequality will decline, but that all world regions will fall short of achieving universal secondary education. **See p.636**

Increased years of schooling have been linked to better health and survival[1], slower population growth[2] and greater economic growth[3]. Because of its importance, access to "inclusive and equitable quality education" was included as one of the Sustainable Development Goals (SDGs) ratified by the United Nations General Assembly in 2015 (see go.nature.com/3ana8ob). The SDGs are an ambitious set of international development targets to be achieved by 2030. Friedman *et al.*[4] provide evidence on page 636 that, although most nations are projected to achieve near-universal primary education by 2030, large inter-regional disparities in the rates of secondary-school completion will persist.

The authors set out to assess whether countries are on track to achieve the SDGs for education by 2030. They assembled a database of 3,180 nationally representative censuses and surveys from 195 nations and territories. This database is an improvement on previous efforts to monitor education, which relied either on data back-projected from a single time point[5] or on a database derived from one-fifth as many data sources[6]. Friedman *et al.* developed a model that combines all the data sources in their data set and extrapolates single-year estimates of educational attainment for all populations, separately by sex and country, from 1970 to 2018. The model then uses this information to project future trends in educational attainment for individual countries or territories, and for seven 'major world regions' chosen by the authors, which include high-income countries, sub-Saharan Africa and Eastern Europe and central Asia.

Friedman and colleagues conclude that most countries are in line to achieve near-universal levels of primary-school attainment by 2030 — that is, for almost 90% of children to complete 6 years of education (Fig. 1). The exceptions to this trend are places such as Afghanistan, Papua New Guinea and parts of northern sub-Saharan Africa. By contrast, progress towards near-universal secondary attainment (12 years of schooling) is more uneven. Only 61% of young adults aged 25–29 years old are expected to have completed secondary school by 2030, and no major world region is expected to reach near-universal levels of secondary-school attainment. Furthermore, access to tertiary schooling is expanding faster in some world regions than in others; as a result, disparities are expected to increase until 2030.

The authors also find that gaps in educational attainment between men and women are expected to have changed substantially by 2030. In 1970, men achieved significantly more years of education than did women in 142 countries. By 2018, this had narrowed to 27 countries, and by 2030 it is projected to be just 4. Moreover, in 18 nations and regions, women are expected to achieve significantly higher mean years of schooling than men. This changing gap is largely attributable to girls' gains in primary schooling.

Next, Friedman *et al.* developed a metric for monitoring educational inequality within countries or territories — average interpersonal difference (AID), which measures the average difference in educational attainment between any two individuals in a population in a given year. The AID provides a different perspective from those of other commonly used metrics.

For example, consider the Gini coefficient, which is perhaps the most commonly used indicator of inequality. Under this coefficient, inequality is highest when education is concentrated in the hands of a few. As access to education expands, the Gini coefficient declines.

By contrast, the AID equates inequality with heterogeneity in educational attainment within a population. When education is concentrated in the hands of the few, the AID is

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Figure 1 | Primary schoolchildren in Dhaka, Bangladesh. Friedman *et al.*[4] analysed the number of years of schooling obtained by children in some 195 nations and territories between 1970 and 2018, and modelled predicted changes to 2030, to assess whether the world will meet the Sustainable Development Goals for education set by the United Nations.

low because most people have the same low level of educational attainment. As access to schooling expands, inequality as measured by the AID rises because the population now contains many people who have no education and many who have several years of schooling. As school enrolment becomes universal and members of the population begin to achieve similarly high levels of education, the AID declines again. From this metric, Friedman and colleagues conclude that global educational inequality peaked in 2017 and is projected to decline until 2030.

Even though this project involves an impressive volume of data, it is still limited by problems of data scarcity. Whereas some high-income countries, such as France and Germany, contribute more than 55 data points to the model, the time series for many resource-constrained and small-population countries or territories are extrapolated from fewer than 5 data points, or rely on data last collected in or before 2008. Although the validity of the model was evaluated by checking how well its predictions matched real data across many simulations in which one subset of data had been removed, there is no way of assessing how well it estimates attainment trajectories for places such as Malaysia, for which no data were available after 2003. The authors leverage regional trends to inform analyses of countries or territories for which data are scarce, but the results should be interpreted with caution.

The smoothed trajectories of predicted change in the study also hide the profound and often sudden impact of education policies on schooling. The authors note nonlinearities in the rates of change consistent with a sudden increase in schooling, which might result from the elimination of school fees or an increase in the years of compulsory schooling. The recent expansion of free secondary education in many lower-income countries has the potential to further advance progress towards the SDG education goals, beyond what is currently predicted by Friedman and colleagues' model.

Ultimately, we can monitor only what we can measure: we track trends in educational attainment and in gaps between the sexes because those are the data that exist. Socio-economic gaps in schooling are now substantially larger than are gender gaps in most world regions[7], but sufficient data on the socio-economic status of students are scarce. Likewise, almost three-quarters of countries have inadequate data with which to monitor progress in learning outcomes (such as mathematics or reading skills), rather than merely in years of schooling (see go.nature.com/39kd4o1). Global commitments to inclusive and equitable quality education run the risk of failing to achieve their true goals when we lack the data to properly track progress.

Monica Grant is in the Department of Sociology, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA.
e-mail: grantm@ssc.wisc.edu

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Organic chemistry

Methyl groups make a late entrance

Emily B. Corcoran & Danielle M. Schultz

The addition of a methyl group to a drug molecule can greatly alter the drug's pharmacological properties. A catalyst has been developed that enables this 'magic methyl effect' to be rapidly explored for drug discovery. **See p.621**

Developing a small-molecule drug requires iterations of building and testing new compounds to find one that strikes the right balance of pharmacological properties. The process typically takes more than 10 years and costs billions of dollars, because, for every 5,000 compounds made and tested, only one will become an approved drug[1,2]. Indeed, a high-school basketball player is twice as likely to end up playing in the US professional league as any single compound tested in a drug-discovery programme is to become a marketed drug (see go.nature.com/2v8pnfm). One approach to accelerating drug discovery is late-stage functionalization, in which previously prepared test compounds are decorated with new atoms in the hope of favourably adjusting their pharmacological properties. On page 621, Feng *et al.*[3] report an outstanding advance towards this long-standing and historically challenging strategy.

> **"This work is a superb example of a symbiotic collaboration between academia and the pharmaceutical industry."**

Introducing just one cluster of atoms (a functional group) into a drug molecule can drastically alter the molecule's properties. For instance, adding a methyl group (CH_3, one of the smallest functional groups) can enhance a compound's binding affinity for its biological target more than 1,000-fold, a phenomenon termed[4] the 'magic methyl effect'. This is because the installation of a methyl group alters the shape of the molecule such that it can readily nestle inside a targeted protein's active site, akin to how an ergonomic computer mouse fits snugly in the palm of your hand.

However, making even small adjustments to molecules is frequently a major undertaking, one that effectively requires chemists to break apart the entire structure and reassemble a dozen or more smaller pieces for each change. Imagine how much time and money it would cost if adding a new window to your home required the entire house to be taken apart and rebuilt from scratch. Chemists working in drug discovery regularly have to do this with their molecules.

Late-stage functionalization has therefore emerged as a desirable approach to accelerate drug discovery[5,6]: much as a construction crew saws through existing walls to insert new windows, chemists aspire to cut through existing chemical bonds to insert new functional groups into molecules. C–H functionalization, a type of reaction that converts ubiquitous carbon–hydrogen (C–H) bonds in complex molecules into alternative functional groups, has garnered much attention for this purpose. Feng *et al.* report a substantial advance in this area with the design of a metal catalyst that cuts through specific C–H bonds to insert methyl groups, thus allowing the magic methyl effect to be explored in myriad complex and drug-like compounds.

Selective late-stage C–H functionalization is constantly used in nature. For example, iron-based metalloenzymes known as cytochrome P450s (CYP450s) are omnipresent throughout the animal kingdom because of their crucial role in regulating metabolism[7,8].