9 The scientific foundations of teaching and learning

[Benő Csapó]

The public education realm is the primary location for acquiring knowledge but *learning* itself goes beyond the boundaries of formal education. The last century, especially its second half, was characterized by the rapid expansion of education: an increasing number of people attended school for an increasing length of time. All means of increasing the extent of formal schooling have, however, been exhausted in most developed countries. What remains in reserve for education development is to improve the efficiency of learning: students do not simply need to acquire more knowledge over the same interval of time spent at school but the knowledge acquired needs to be of much better quality, fully comprehended and ready to be applied more broadly. This objective – similarly to other areas of society and the economy – can only be achieved if the development process relies on scientific research.

The expansion of learning – in contrast with the expansion of formal education – has not yet reached its limits; on the contrary, it is in full flow and has transversed the boundaries of schooling in two directions. First, learning is for life: it is a central process in people's lives even prior to the start of formal schooling and it continues for an entire lifetime *(lifelong learning)*. Second, learning permeates every aspect of life; simple everyday activities, subsistence, communication and workplace duties all call for the acquisition of new knowledge *(life-wide learning)* and informal learning has an ever greater role. Establishing the scientific foundations for teaching and learning means understanding and developing this complex social knowledge-generating process through research.

While the education system is the most important sphere for regenerating knowledge on a social scale, the system itself makes very little use of new knowledge or new scientific discoveries in improving its own activities.

The deepest paradox in connection with the role of education in social development is that while the education system is the most important sphere for regenerating knowledge on a social scale, the system itself makes very little use of new knowledge or new scientific discoveries in improving its own activities. In short, education does not belong to the class of knowledge-intensive sectors. This paradox is repeatedly noted by international and national organisations and countries are urged to expand the scientific background of learning and instruction and to enhance research capacities. The call has led to a flow of spectacular developments in some countries while others – including Hungary – are only just beginning to recognise the problem.

In knowledge-intensive sectors development is driven by incoming knowledge and changes are based on scientific research and development activities.

A more than ten year old overview by the OECD found, for instance, that expenditure on research and development in relation to learning and instruction amounted to barely a few thousandths of the education budget in several countries (OECD, 1995). The public education system is the sector with the largest number of professionals with higher education degrees, which demands enormous financial resources, and yet it relies only to a very small extent on scientific evidence for professional development compared to other sectors. In some countries, research expenditure remained below a measurable level.

In placing the issue of research driven education development in a broader socio-economic context, it should be remembered that some countries spend almost 4 per cent of their GDP on research and development. This ratio is probably much higher in knowledge-intensive sectors.[1] That is, to turn education into a knowledge-intensive sector, an accelerated expansion of research capacity, improved infrastructure and researcher training are an essential prerequisite.

Countries achieving excellent results in recent international surveys contributed the same value to education research as they did to developing knowledge bases for other sectors.

An analysis of the relationship between knowledge, economy and education provides plenty of direct and indirect evidence demonstrating that enhancing research on education is one of the most profitable investments. Countries achieving excellent results in recent international surveys give further support to this view. Looking at development processes over the last few decades, it can be clearly established that these countries owe their rapid progress to the marked attention they paid to research and development in science and technology and, in a prominent position within that, to an attitude that contributed the same value to education research as was given to developing knowledge bases for other sectors. A development process thus emerged relying on pilot schemes and scientific evidence, which is the approach that, among others, OECD programmes are keen to propagate (SCHLEICHER, 2006).

■ DIAGNOSIS

1. *Research aimed at creating the scientific foundations of education development.* The first empirical educational research programmes of scientific value were launched towards the end of the 19th century. In Hungary, however, neither the period between the two World Wars, nor the years after World War II were characterized by social conditions conducive to research in the social sciences in general and even less so to empirical educational research in particular. It was only following World War II, however, that Hungary was

[1] Two extensive economic regions, the United States and Southeast Asia, with which the European Union should keep pace, persistently spend over 3 per cent of GDP on research and development. This value is one of the targets of the Lisbon strategy, set to be attained by 2010 (which is now known to be beyond hope). While some countries now spend as much as 4 per cent, the corresponding value remains under 1 per cent in Hungary.

quickly left behind by other countries where – mostly following the lead of the United States – a dynamic methodological development process was set in progress. In Central and Eastern Europe, in contrast, the development of social sciences came up against ideological barriers. In Hungary, organized, systematic empirical education research only emerged in the 1970s. Following a decision concerning education policy made in 1972, Research Directive No. 6 was launched in the middle of the decade, which was succeeded by a programme entitled 'Public Education Research' in the 1980s. Comparatively ample resources for that time were allocated for the project and distributed to researchers through a competition-based funding system modelled on Western research grant schemes. The research budget of about 20 million Hungarian forints, which was an exceptionally large sum in terms of contemporary purchasing power, "disappeared" at the time of the regime change, then reappeared in the 1990s as a fund of 50 million forints, which was worth significantly less (and was distributed with the help of the Education Committee of the Hungarian Academy of Science), before disappearing once again.

The present position of *educational sciences*[2] meant to provide the foundations of education development is equally problematic in comparison to its earlier position, to other fields of science and to the position of the same discipline observed in other countries. Educational sciences have no dedicated research funds, no university research teams specializing in empirical studies and very few qualified researchers. There are limited opportunities for disseminating research findings and quality professional journals are facing the threat of closure. The annual National Conference in Education Studies launched in 2001 is the only peer-reviewed academic conference in Hungary that accommodates the entire spectrum of education sciences and provides a regular forum for the presentation of research findings. The conference does not have stable sources of funding with the organizers struggling to raise funds year after year.

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Educational sciences were, until very recently, classed together with the humanities. Their institutional framework and research funding conditions are still typically shaped by mechanisms belonging to the humanities. This tradition does not cater for the financial needs of research, the accommodation requirements for equipment and assistant staff needed for empirical research or the maintenance of computer infrastructure essential for data analysis. Education departments are typically small relative to their teaching load, they have low prestige, their development has a very low priority in their host institutions, and the task of building the infrastructure needed for empirical research is hampered by sceptical attitudes as well as financial barriers. It is difficult to make a reliable assessment of research conditions as the available statistical data are inconclusive. In accordance with an earlier government decree – since amended, – the Hungarian Statistical Office uses the category of "educational

[2] The term is used here in a broad sense encompassing a wide range of research subjects, some extending to the boundaries of psychology, sociology, economics or a series of other disciplines.

and sport sciences" to record the amount of financial support given to the field as well as the details of the research infrastructure, human resources (number of researchers, share of researchers with Ph.D. or equivalent qualifications) and the research outcomes (number of publications).

Since empirical research requires substantial resources and because at several higher education institutions instructors working in teacher education departments are under considerable pressure to obtain advanced academic qualifications, a major share of Ph.D. dissertations and higher doctorate works focus on less cost-intensive subjects, and studies relying on empirical investigations of learning and instruction are less widely represented. Few young researchers studying for their Ph.D. degrees are prepared to master the details of statistics and research methodology needed for empirical social science research.

There are two contexts in which the relative weaknesses of the scientific background of education can be shown. First, we can look at its context within the country to reveal how the scientific background of education compares to that of other sectors and second, we can compare Hungarian conditions to conditions observed in other countries. In what follows, the discussion of a within-country comparison will be restricted to an overview of possible approaches, which will be followed by the description of a few initiatives which can be seen as country models.

Three sectors are worth considering in a within-country comparison: agriculture, medicine and education. Their positions allow analogous analyses in the sense that all three are under the control of a government department and the relevant ministries have substantial funds at their disposal. Each of the three sectors is tied to an applied science that relies on the research findings of several different disciplines: agricultural science, medical science and educational sciences. There are, however, enormous differences between the three fields in terms of their funding, human resources, and institutional and infrastructural conditions — with education lagging behind the other two.

Focusing on only general features without entering into any detail, it is worth mentioning a few figures as an illustration of the problems. Agriculture is supported by wide-ranging background research and an extensive institutional network and infrastructure. The team of development experts and senior researchers with advanced academic qualifications employed in agriculture far exceeds in size the research workforce in education. These facts unequivocally suggest that in present day Hungary agriculture is a much more knowledge-intensive sector than education. Since agriculture is a productive, market-oriented industry, it cannot be compared to education in every respect. The parallel between medicine and education is easier to interpret, and proposals for development in instruction and, especially, in teacher training often put forward medical science and medical training as positive examples (see, for instance, DARLING, HAMMOND & BRANSFORD, 2005). The country needs about three times as many teachers as doctors. With these proportions taken into consideration, we find that there are at least 15 times as many researchers with Ph.D. degrees to every ten thousand medical doctors as there are to the same number of teachers. Looking at researchers with Doctor of Sciences (a degree awarded by the Hungarian Academy of Sciences), the corresponding ratio is 30 to 1 and in terms of papers published in journals abroad we find a ratio of 120–150 to 1.[3] A related observation is that there are only four research universities offering medical training, while teacher education is much more fragmented, it is distributed across more than thirty institutions. The research university model — where training is coupled with research and development, and where the knowledge base of education is continually recreated — could also be adopted.[4]

Research and scientifically based training capacity is constrained to such an extent that the sector is scarcely capable of exploiting opportunities – such as EU support – that offer themselves. The available grants are typically not large enough to finance large-scale empirical studies.

It follows that the education development process is backed by very limited research or scientifically based training capacity in comparison to the weight of the tasks awaiting fulfilment. This capacity is constrained to such an extent that the sector is scarcely capable of exploiting opportunities that offer themselves, such as absorbing EU support. Sources of funding research in education sciences include the Hungarian Scientific Research Fund (OTKA), grants of the Hungarian Academy of Sciences and other research and development funds. The available grants, however, are typically not large enough to finance large-scale empirical studies.

2. *The gap between Hungary and other countries — successful programmes abroad*. The problems of educational research in Hungary are aptly illustrated through a comparison with other countries: while other countries have launched impressive development programmes expanding research capacities, the past twenty years in Hungary have been essentially characterized by stagnation even though international initiatives could have been used as models for the modernization of research in educational sciences. Once the weaknesses of their education system had become apparent and the connection between education and knowledge economy had been recognized, a notable group of these countries set out to improve academic background activities, institutional infrastructure and human resources at a fast pace. In these countries — while outcomes may not yet be measurable — research on learning and instruction is now one of the most dynamically developing fields in empirical social sciences.

Some countries set out to improve scientific background activities, institutional infrastructure and human resources at a fast pace. In these countries, research on teaching and learning is now one the most dynamically developing fields in empirical social sciences.

The weaknesses of the American education system have been recognised for decades. The problem has also been documented by international comparative studies. In the 1970s and 1980s American pupils displayed one of the poorest performance ratings in mathematics and science. Large differences observed between different ethnic groups and social groups presented an enormous problem. Students dropped out of school prematurely. Thanks to sustained efforts, in which scientific findings played an increasingly significant role, American

[3] The precise ratios cannot be calculated because, as was mentioned previously, educational sciences and sport sciences are merged in the statistical database. The estimates given here take the combined figures of the two fields; the actual situation is — to an unknown extent — worse than that.
[4] See also Chapter 8 of this volume and Csapó (2003, 2004, 2007, 2008).

pupils advanced to somewhere around the middle of the range by the end of the millennium. Although empirical research in educational sciences has always had a tradition of high standards at American universities, the practical application of research findings and the task of advancing teacher education had proved to be a challenge and the process is still not, even today, free from contradictions. The *No Child Left Behind* Act of 2001 specifically emphasizes the need for scientific foundations and evidence-based methods in education. In addition to new institutions of educational research and an increase in allocated resources, the Act has also given rise to a reinterpretation of scientifically based educational research (CSAPÓ, 2003, 2004). As the Act contains several references to the requirement of a scientific basis, and federal funds of millions of dollars are allocated every year to researchers and for the dissemination of evidence-based methods, educational research is also regulated by law. The requirements drawn up by a committee of the National Academies call upon researchers in educational sciences to adhere to the research standards of the natural sciences and especially those of engineering and medical sciences (FEUER, TOWNE & SHAVELSON, 2002; SHAVELSON & TOWNE, 2003). Efforts to improve reading education are especially noteworthy, such as the formation of the *National Reading Panel*[5], reflecting broad-ranging academic collaboration.

Europe's largest national educational research programme organized in a uniform structure across the board has been launched in Great Britain. The *Teaching and Learning Research Programme*[6] relies on a synergy between a wide range of academic disciplines and extends to all major aspects of teaching and learning. It encompasses seventy major projects grouped into twenty subject categories, which engage more than 700 researchers. By the summer of 2007 its budget reached 43 million pounds. Its declared aims include developing capacity for research and improving relations between researchers, practitioners and policy makers. The co-ordination office of the programme has been involved in co-ordinating similar national educational research programmes in other countries.

Germany has experienced both education and research problems which are in several respects similar to those observed in Hungary. The selective education system of Germany, which funnelled pupils to different types of school at an early stage of education, created similar tensions to those caused by the more or less covert, spontaneous practice of selection characteristic of Hungary. The development of empirical control was hampered by a pronounced humanistic, philosophical approach to social sciences. Warning signals communicated by researchers were suppressed by the wide public support for the school system. Thus, German society was literally shaken by the results of the PISA surveys and the PISA-shock engendered a truly broad ranging social, professional and education policy debate. It was being put to the test in an international context

[5] The National Reading Panel website: http://www.nationalreadingpanel.org.
[6] The Teaching and Learning Research Programme website can be found at http://www.tlrp.org.

that gave the final impetus to the long-simmering all-inclusive changes. The reforms focus on creating the scientific foundations of education and putting research findings to wider use. Germany had accommodated prominent, internationally acclaimed research centres before, such as the Max Planck Institut[7] in Berlin and the Leibniz-Institut für die Pädagogik der Naturwissenschaften[8] (IPN, Leibniz Institute for Science Education) at the University of Kiel. A further institution was established in 2004 at the Humboldt University of Berlin, the Institut zur Qualitätsentwicklung im Bildungswesen[9] (IQB, Institute for Education Progress), which is charged with specifying educational standards and developing an assessment system ensuring that these standards are observed. Existing research institutes[10] have been given new profiles and new, empirically oriented university departments and research centres have also been set up with the same objectives in mind.

In Finland, educational research entered into a rapid stage of development in the late 1970s. This is partly credited to the fact that the most gifted members of the then young generation of researchers were sent to prominent research centres around the world as visiting scholars and at a later stage their students received support enabling them to obtain their Ph.D. degrees abroad. Research and development centres were set up at universities and, as a next step, strong links were established between research and teacher training. Notable examples include the two fairly large research centres mainly specializing in educational assessment which conducted the PISA surveys in Finland. The Institute for Educational Research[11] is affiliated to the University of Jyväskylä and the Centre for Educational Assessment[12] is part of the University of Helsinki. With respect to the issue of enhanced financial support for research on learning and instruction and the responsibilities of a science academy, the complex research programme entitled *Life as Learning* launched by the Academy of Finland constitutes a good example. The programme had a budget of 5.1 million Euros for 2002–2006. Funds were allocated on the basis of English language proposals which were evaluated by an international panel. Research results were regularly presented at international conferences. The priorities of evaluation included partnership with schools, training young researchers and expanding research staff (CSAPÓ, CSÍKOS & KOROM, 2004).

Looking at the known weaknesses of the Hungarian public education system and at international trends allows us to identify the major areas of research and development with the greatest need for capacity development. Important decisions now tend to be made on the basis of tradition, without the support of scientific evidence.

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[7] The MPI Berlin website: http://www.mpib-berlin.mpg.de/en/forschung/eub/index.htm
[8] The IPN website: http://www.ipn.uni-kiel.de/institut_eng.html
[9] The IQB website: http://www.iqb.hu-berlin.de
[10] The Deutsches Institut für Internationale Pädagogische Forschung in Frankfurt, for instance, has abandoned its old profile of traditional, descriptive comparative educational research to become one of the leading centres of empirical research.
[11] The website of the Institute: http://ktl.jyu.fi/ktl/english
[12] The website of the Centre: http://www.helsinki.fi/cea/english/kenentehtava/eng_kansalliset.htm

Hungary. The areas in question are those that have a decisive influence on the efficiency of the education system, but where important decisions are made on the basis of tradition or subjective opinion without the support of scientific evidence and where it has been shown by the experiences of other countries that research matters and research findings can be put to good use.

3. *Research based development of programmes, curricula and instructional materials*. The significance of early child development and possibilities for its facilitation are demonstrated by a range of studies. The development of the brain/nervous system, emotions, language and numerical skills has an especially rich literature. Further extensive research is needed, however, to identify ways of transferring research results into school practices and to develop early childhood programmes, especially in the area of compensating for developmental delays and social disadvantages.

Developing new classroom methods and "calibrating" their effects can advance the renewal of educational culture.

It is above all the development of new classroom methods and the "calibration" of their effects that can advance the renewal of educational culture. First of all, methods that reach beyond teacher centred large group work and enhance understanding, application, skill development and motivation need to be developed. A broader repertory of differentiated instructional methods and demonstrably efficient education procedures is also required to allow integration and the co-education of heterogeneous groups of pupils, which, from several points of view, is a desirable goal.

Hardly any funds are available to investigate the efficiency of teaching materials and give scientific support to development. More than ten different series of course books are used to teach reading but they have never been subjected to research in order to test and compare their efficiency.

Textbook publishing and the development of digital, multimedia instructional materials are a multi-billion forint business. Compared to that, vanishingly small funds are available to investigate the efficiency of teaching materials and give scientific support to development. This area is, moreover, characterized by egregious squandering. More than ten different series of course books are available for reading instruction, for instance, but they have never been subjected to research in order to test and compare their efficiency. The development of multimedia tools is mainly dependent on technological circumstances rather than on scientific findings in relation to instruction or on considerations of developmental psychology or education theory.

At present curriculum development is shaped by opinions, traditions and debates between ideological, political or professional interest groups. It is a century old objective of researchers and education reformers to create curricula attuned to child development. In recent decades, research in instructional sciences has generated a great body of information needed for research based curriculum development, preparing the ground for a shift from contents-centred curriculum design to child-centred design. One of the main trends in curriculum development focuses on skills and abilities. It aims to structure education around a "thinking curriculum."[13] Similarly important tasks include a detailed

[13] New approaches to skills development and associated experimental work are discussed by Mrs. NAGY (2000, 2006), for instance.

investigation of pupils' conceptual development, an examination of conceptual change and the developing of curricula in harmony with the results. In Hungary, however, these questions have only just emerged as issues for in-depth research and ongoing projects do not cover all ages from the beginning to the end of schooling, nor do they extend to all domains of knowledge.[14]

Comprehensive competence assessments (in grades 4, 6, 8 and 10) are exceptionally important. However, there are no resources for generating the professional knowledge needed to interpret the results and, as a consequence, this body of data has little practical benefit.

4. *Educational assessment and quality encouragement*. It is a wide-ranging research and development task to establish the scientific foundations of educational assessment. The recently introduced comprehensive national competence assessments (in school years 4, 6, 8 and 10) are very important both for education policy and in assisting instruction. No resources have been allocated, however, for generating the professional knowledge needed to interpret the results and, as a consequence, this potentially very useful body of data has comparatively little impact on education. To advance public education, the assessments costing several hundred million Hungarian forints must be based on the findings of systematic research activities, and scientific methods must be used to interpret the results and draw conclusions. In addition to data on family and environmental background variables currently gathered on a regular basis, affective variables (motivation, self-concept, attitudes, future expectations, attributions, etc.) should also be examined on smaller sub-samples. One of the most interesting analyses of the PISA survey of 2000, for instance, was a study based on the results of research on self-regulated learning, which revealed several interesting patterns in pupils' learning strategies, habits and attitudes to learning (ARTELT, BAUMERT, MCEVANY & PESCHAR, 2003).

Although in Hungary — similarly to other countries — assessment and evaluation is at the forefront of empirical educational research, its theoretical foundations offer further potential for development. It is an important research task, mostly of practical applicability, to introduce further functional differentiation into the assessment of different age groups. Various diagnostic and screening functions at the start of compulsory schooling could be further improved to enhance their development and criterion-referenced nature.[15] This could assist the early recognition of problems and the use of appropriate therapeutic procedures and differentiated instructional methods, which could in turn reduce the odds of pupils dropping out of school.

The introduction of the new two-tier school leaving examination *(Matura)* system of standard vs. advanced level examinations was not preceded by preparatory work of establishing and setting benchmarks, or by a sufficiently detailed analysis of the expected effects and side effects of the system. The new examination system therefore gave rise to several problems. The two-tier

[14] For a discussion of relevant research in Hungary see, for instance, KOROM (2000, 2002, 2005).
[15] A widely used instrument of this type is the Hungarian test package DIFER (Diagnostic Development Assessment System — see NAGY, JÓZSA, VIDÁKOVICH & FAZEKAS, 2002, 2004).

structure is not in harmony with the reform process: it (inappropriately) calls for an early decision just when the multi-level higher education system has finally deferred the decision on education level to a later stage. The knowledge conception underlying the examination has not been elaborated on a scientific basis, the relationship between the two tiers has not been defined, item banks needed for technical delivery have not been developed and test items have not been calibrated. Item response theory allows for the expression of the current two examination levels on a single scale.

International surveys offer good opportunities for the external evaluation of the efficiency of the education system as a whole. Hungary participates in a number of major assessment programmes (PISA, TIMSS, PIRLS, etc.).[16] The four yearly TIMSS (see, for instance, MULLIS, MARTIN, GONZALEZ & CHROSTOWSKI, 2004) focuses on curriculum-related knowledge while the OECD's three yearly PISA survey (OECD, 2000*a*, 2000*b*, 2001, 2003, 2004*a*, 2004*b*) assesses the applicability of knowledge outside the school and its utility in society. The potentials of these surveys, similarly to those of local national surveys, are left unexploited. Concentrating staggering mental capacity, the PISA surveys reveal the positive and negative aspects of individual education systems and thus suggest directions for future development. The analyses produced on the basis of the results, however, have a far weaker impact in Hungary than would be necessary. Synthesised analyses relying on the results of international assessments are regularly produced in other countries (see, for instance, HAAHR, NIELSEN, HANSEN & JAKOBSEN, 2005).

International surveys offer good opportunities for the external evaluation of efficiency. Their potentials, similarly to those of local national surveys, are left unexploited. Synthesised analyses relying on the results of international assessments are regularly produced in other countries.

In Hungary, not even university libraries stock copies of the original editions of the summary reports (several dozens of volumes). Although it is possible to download the complete databases from the internet, most researchers do not have the skills or capacity to use and analyze the data. The few researchers who possess the necessary skills to cope with analysis tasks of this complexity cannot be burdened with this work in addition to their regular duties and, moreover, there are no channels through which thorough analyses could be transferred to development programmes. Once again, the solution lies in following the lead of countries that invest at least as much in the locally relevant analysis and practical exploitation of results as they do in administering the surveys themselves. In the long term, it should also be our objective to empower Hungarian researchers to contribute to the scientific foundations of international surveys.

Hungary should follow the lead of countries that invest at least as much in the locally relevant analysis and practical exploitation of results as they do in administering the surveys themselves.

The primary aim of diagnostic assessment (VIDÁKOVICH, 2001) is to monitor and facilitate learners' progress, to allow problems to be recognized in good time for each individual and to identify appropriate complementary activities. One such programme in Hungary is the DIFER package (Diagnostic Develop-

[16] PISA: *Programme for International Student Assessment*; TIMSS: *Trends in International Mathematics and Science Study*; PIRLS: *Progress in International Reading Literacy Study.*

ment Assessment System), which is available at every primary school (see NAGY, JÓZSA, VIDÁKOVICH & FAZEKAS, 2002, 2004).

An increasingly important role is assigned to assessing the efficiency of instruction. This can be done by means of comprehensive national surveys that provide comparable assessments of the knowledge and progress of pupils at different schools. A system of annual assessment procedures is currently under implementation in Hungary. The conception behind the system is to supply data of appropriate quality that can be aggregated to compute indicators characterizing the efficiency of instruction. At present, however, no scientifically sound methods have been found for the task and the development of models providing a framework for computations requires extensive research. (See Chapter 7 on assessment and evaluation for details.)

Info-communication technology radically transforms education and brings large-scale improvement in the accessibility of knowledge and in the quality and applicability of the knowledge acquired.

5. *Knowledge rich learning environment*. Educational culture can now be fundamentally transformed thanks to information and communications technology and new electronic instructional materials (see, for instance, KÁRPÁTI, 2001). It must be remembered, however, that these tools will not provide a solution to problems by themselves and the unique opportunities offered by the availability of multimedia methods frequently remain unexploited. There can be no doubt today that info-communication technology radically transforms education and brings large-scale improvement in the accessibility of knowledge, and in the quality and applicability of the knowledge acquired. It should also be recognized, however, that the fast pace of development has the consequence that users cannot always keep up with the opportunities on offer. Info-communication often offers first-rate solutions to second-rate problems.

If info-communication is not used with sufficient responsibility, the changes may lead to the fragmentation of knowledge. There is an increase in "noise," irrelevant, misleading or false knowledge reaches learners just as readily as valid, useful knowledge.

If the spread of information and communication technology is allowed to be a spontaneous process, groups or schools better prepared to stand up for their interests may gain a significant advantage, which leads to an increase in inequalities between schools — to the emergence and widening of a digital divide. If info-communication technology is not used with sufficient responsibility, the changes may lead to the fragmentation of knowledge. There is an increase in "noise" — irrelevant, misleading or false knowledge reaches learners just as easily as does valid, useful knowledge. It is a well known phenomenon that formal education may "duplicate" the world: to the body of realistic, experience-based and real-life knowledge, a level of abstract school-based knowledge, distanced from reality, may be added. If development is not rooted in scientific research and effects analysis, there is a danger of info-communication giving rise to a third world by transmitting knowledge which is only valid in the "virtual world" and has little connection with "real life" knowledge.

Nevertheless, the use of info-communication technology offers richer opportunities and perspectives in the development of education than any other educational tool has done before. Communications networks offer partnerships for work and novel ways of interaction between learners and teachers and between individual learners. Multimedia allows knowledge to be represented in

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new ways, which, in addition to aiding comprehension, enhances motivation. If used and distributed appropriately, info-communication technology can also be a suitable means of compensating for social disadvantages (see, for instance, KÁRPÁTI & MOLNÁR, 2004). Educational computer software can be an excellent tool in individualization efforts, in delivering personalized education adjusted to individual learning speeds. Educational computer programmes aiding knowledge integration and comprehension have especially great potential.

6. *Scientifically based teacher education*. The first large wave of modernization in teacher education took place in the second half of the 20th century. The objectives of the time centred around the notion of professionalization in teaching. Thanks to this approach, the process of organising knowledge needed for success in the teaching profession and, as appropriate, of setting up targeted research programmes was greatly accelerated. It became clear that teaching experience alone is not sufficient as a teachers' knowledge base. In the absence of appropriate theoretical frameworks and scientific foundations experience alone cannot give rise to widely applicable and valid knowledge; it may, instead, lead to erroneous generalizations and the emergence of naive models. This is especially true in situations where the requirements of a given profession change very rapidly. Where this is the case, the experiences of the previous generation largely lose their validity. The role of new generations entering the profession may be the most significant factor in renewal. It was this argument that prompted Western countries to enhance the scientific foundations of teacher education and to improve the integration of theoretical and practical training.

In the absence of appropriate theoretical frameworks and scientific foundations experience alone cannot give rise to widely applicable and valid knowledge; it may instead lead to erroneous generalizations and the emergence of naive models.

New directions in teacher education go even further in plans to build a knowledge base of teaching. Research-based teacher education now aspires to empower teachers to interpret, grasp and apply scientific findings without mediation and even to conduct independent educational research themselves.This approach is most clearly represented by the Finnish *research-based teacher education system*, which has a history of almost two decades and which is one of the key components of the famously successful Finnish education system (NIEMI & JAKKU-SIHVONEN, 2005; JAKKU-SIHVONEN & NIEMI, 2006). This has its roots in the observation that research on learning and instruction produces new results at such a pace and in such quantities that it has become impossible to disseminate those findings through traditional procedures of interpretation and incorporate them into school subjects.

Research-based teacher education needs to empower teachers to interpret, grasp and apply scientific findings without mediation and even to conduct independent educational research themselves.

7. *Education policy based on scientific evidence*. As a result of a few, generally speaking, independent processes, efforts to rely on scientific evidence in making education policies have been intensified in recent years. Firstly, educational research is developing at a fast pace and thus education policy makers have access to a growing body of evidence that can be used in making decisions. Secondly, the requirement of accountability now applies to government adminis-

tration, including the administration of education and health services, the great social service programmes. Thirdly, the results of international assessment programmes (IEA, PISA) have opened the way to systemic analyses that have brought the weaknesses of the education systems of individual countries to the surface while also providing information on how other countries avoid similar problems, which is of direct use to education policy.[17] Scientifically based education policy relies on evidence provided by research — this is reflected by the term *evidence-based education policy* used in literature on the subject.

Several countries and international organizations are making special efforts to expand research capacities in order to allow education policies to be based on scientific evidence.

Evidence-based education policy is gaining more and more ground. Several countries and international organizations are making special efforts to expand research capacities in a way that allows education policies to be based on scientific evidence. In an effort to propagate evidence-based education policies, the OECD organized a series of international conferences. (The conferences were hosted by Washington,[18] 2004; Stockholm, 2005; The Hague,[19] 2005; and London,[20] 2006.) The studies[21] revealed substantial differences between the countries in this area as well.

Government education departments in some countries (e.g., in Great Britain), employ trained researchers, or "knowledge brokers" to use their research expertise to provide continuous analyses of current or expected problems in education and to identify solutions to these problems which are proven or inferred to be effective based on the relevant literature. In some cases research is commissioned to find scientific evidence relevant to a policy decision. Countries receptive to the OECD's recommendations have already begun to implement them. Germany is one these countries. In fact, Germany included the propagation of evidence-based education policy among the main programmes of the German EU presidency. Evidence-based education policies have also emerged in Hungary.

■ SUGGESTIONS

The most important lesson learnt from international experiences is that intensive efforts are needed to achieve a breakthrough; minor adjustments, not even comparable to the gravity of the problem, cannot lead to success in this area. First of all, adequate funds need to be established. The task calls for billions of Hungarian forints, which in the context of current conditions seems to be

[17] The term education policy is used here in a strategic sense and covers school and maintainer level policies as well as national policies.
[18] Website: http://coexgov.securesites.net/index.php?keyword=a433923e816991
[19] Website: http://www.oecd-conferences-ocw.nl/ebpr-conference/index.html
[20] Website: http://www.oecd.org/document/24/0,2340,en_2649_35845581_36810776_1_1_1_1,00.html
[21] The results of the analyses have been published in a volume: OECD (2007).

Adequate funds are needed and reliable long-term grants distributed through a competitive grant system. Requirements can be modelled on frameworks developed in natural and engineering sciences and on itemized foreign benchmarks.

a large sum but, in actual fact, constitutes only a few thousandths of the total public education budget. Resources should be distributed through a competitive grant system and should be granted to successful applicants undertaking long-term projects that may lead to publications of an international standard. Requirements can be modelled on frameworks developed in natural and engineering sciences, other social sciences or on itemized international or foreign benchmarks.

A further feature of foreign models that can be adopted is that other disciplines may be invited to take part in research programmes, to bring their own approaches and from time to time enrich education sciences with their well-established "harder" research methods. In this respect a fairly broad spectrum of disciplines could be useful, since research on learning and instruction could benefit from the experiences of neuroscience, cognitive neuro-psychology, cognitive science in general, psychology, sociology, economics, informatics and several other fields.

Instructional Science Research Fund

1. The key step to a solution is to set up an *Instructional Science Research Fund* exclusively dedicated to funding research on teaching and learning. This step has been taken by several countries. The fund should conform to international standards and should be set up in international collaboration. Satisfying the knowledge requirements of education calls for adherence to the principles of competition-based research funding, which is now common practice in Hungary, together with the introduction of several additional conditions and requirements.

Research universities

2. Provision for *research universities* in the field of educational research. There should be support for research groups at institutions offering Ph.D. training and master's training. The Higher Education Act contains references to that effect.

Large-scale long-term projects

3. Scattered minor initiatives should be replaced by relatively *large-scale long-term projects* (a good example is the British *Teaching and Learning Research Programme* and the Finnish *Life as Learning* project). A programme of four to six years' duration with at least three to five researchers working on the programme is the minimum needed to begin making a difference.

Ph.D. students, postdoctoral fellows

4. Supported programmes should specifically seek to expand research capacity. Provision should therefore be made for a substantial share of research duties to be fulfilled by *Ph.D. students and postdoctoral fellows*.

Foreign researchers

5. Channels should be created for international knowledge transfer. Research groups should be able to invite *foreign researchers* and research group members should be given the opportunity to participate in the work of research groups abroad.

Involve teachers in projects.

6. Research groups should maintain *long-term collaboration with a sufficiently large number of schools*, keep their partners up to date on the progress of their research and involve teachers in their projects.

7. Research group members should contribute to pre-service and in-service teacher education. This allows their valid research findings to permeate instructional practices with the shortest possible delay.

8. Educational development and services requiring a research base (e.g., curriculum development, establishing benchmarks, developing instructional materials, assessment and evaluation) should be gradually transferred to successful, *internationally acclaimed research groups*.

■ COSTS, TIMING

Since at present the funds allocated for educational research are almost negligibly small, even moderate financial support can lead to a multiplication of scientifically based evidence if used efficiently. The annual budget for education is of the order of a thousand billion Hungarian forints; research expenditure, as shown by official figures, accounts for about 0.2 per cent. An increase of just a further 0.2 per cent could allow the objectives discussed above to be realized within the next decade. That is, merely 2–2.5 billion forints would be needed — the cost of a few miles of motorway — to set the education system on course to become a knowledge-intensive sector.

The New Hungary Development Plan pumps substantial funds into education system development programmes, which include some research components. Thanks to these initiatives, significant research and development projects will be launched over the next few years. This in itself does not guarantee, however, that the kind of human resource and infrastructural development proposed above will indeed take place. Steps must therefore be taken to ensure that programmes lead to lasting changes. Care must also be taken to keep development processes sustainable.

To achieve this aim, a bill to set up the Instructional Science Research Fund proposed above should be enacted as soon as possible. The initially moderate financial resources needed to provide for the Fund should be incorporated into the budget. The first step should be taken as early as 2009, with 0.05 per cent of the education budget allocated to the Fund. This should be followed by an annual increase of 0.05 per cent leading to an expenditure of 0.2 per cent by the end of the Social Renewal Operational Programme (TÁMOP) of the Development Plan (0.1 per cent in 2010, 0.15 per cent in 2011 and 0.2 per cent in 2012). After this period, an annual growth rate of 15–20 per cent is reasonable to expect as research capacity gradually expands until the total R&D expenditure of the sector attains 1 per cent of the gross education budget. These sums are negligible relative to the total central budget but they are of decisive significance for the future of education.

■ LINKS TO OTHER PROGRAMMES

The task of enhancing the scientific foundations of education is connected to several other development programmes. The implementation of any proposed change should be preceded by a scientifically conducted feasibility study and efficiency analysis. Research is most closely tied to training, in our case to the training of researchers (Ph.D.), and education experts (master's level and specialized professional development) and to pre-service and in-service teacher training. These are the training channels through which research-based knowledge can be introduced into the public education system. If there is an absence of good quality scientific research, there can be no new knowledge to teach.

■ EXPECTED GAINS

Education can be set on course to become a knowledge-intensive sector by enhancing scientific capacities. In the short term, this will slow down the growth of the gap between Hungary and the developed countries. In the medium term, the gap can be stabilized and in the long term Hungary can start approaching the level of the developed world. Research should above all be targeted at solving problems, including providing assistance for the education of children of families in disadvantaged social positions, reducing the incidence of children dropping out of school and improving the quality of students' knowledge when they finally leave school.

■ RISKS AND SIDE EFFECTS, INTERESTS, CONFLICTS

The measures proposed here are not accompanied by any serious risks or side effects. They will primarily benefit young gifted researchers who are thus given more professional opportunities (they are unfortunately rather few in number). Enhancing the efficiency of education finances and the introduction of a stricter control of productivity will presumably not encounter objections from major social groups. It might, at most, cause displeasure for those who cannot have access to the new research funds.

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