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Backgrounds and Goals of 'Innovations': The Examples of New Math in the 1960s and the Change from Input to Output 1995

Abstract: *Every innovation should be questioned critically in the sense of humanization of education, in particular with regard to the context and overarching objectives for which an innovation is effective. That innovations are not always improvements will be shown on two international examples from the last six decades.*

In the 1960s, triggered by the so-called Sputnik shock, an innovation was initiated by the OEEC (OECD). In the interests of the economy, the number of educated people in mathematics and science should be increased. In connection with this, the innovation known under "New Math" for teaching mathematics was born.

A further international innovation started in the mid-1990s stimulated by the results of the comparative OECD studies TIMMS (1997) and PISA (since 2000) which also focused on mathematics and science. This meant a change from input to output (final tests) and the change of the school system according to organizational forms of business management.

Key words*: education as the third factor of the economy, New Math, change from input to output in the 1990s, business management at school, questioning the overarching goals of an innovation.*

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摘要 *(Günter Graumann: "创新"的背景和目标：1960年代新数学的实例以及1995年从投入到产出的转变）：在人性化教育的意义当中，任何一项创新都应该被质疑，尤其是旨在影响创新环境及更高层次的目标方面。过去六十年中的两个国际案例表明创新并非总是进步这一事实。*

在所谓的人造卫星的冲击下，经济合作与发展组织在1960年代发起了一项创新。为了经济的利益，应提高在数学和自然科学领域的受教人数。 在这种情况下，诞生了被称为"新数学"的创新数学教育。另一项国际创新始于1990年代中期，受到经济合作与发展组织的比较研究，TIMSS（1997年）和PISA（自2000年）的结果的启发，二者同样侧重于数学和自然科学，以及从投入到产出的转变（最终测试）和 根据企业治理的组织形式而导致的学校系统的改变。

关键词：*教育作为第三经济因素，新数学，在1990年代从投入到产出的转变，学校的企业治理，一项创新的更高层次的目标的质疑。*

摘要 *(Günter Graumann: "創新"的背景和目標：1960年代新數學的實例以及1995年從投入到產出的轉變）：在人性化教育的意義當中，任何一項創新都應該被質疑，尤其是旨在影響創新環境及更高層次的目標方面。過去六十年中的兩個國際案例表明創新並非總是進步這一事實。*

在所謂的人造衛星的衝擊下，經濟合作與發展組織在1960年代發起了一項創新。為了經濟的利益，應提高在數學和自然科學領域的受教人數。在這種情況下，誕生了被稱為"新數學"的創新數學教育。另一項國際創新始於1990年代中期，受到經濟合作與發展組織的比較研究，TIMSS（1997年）和PISA（自2000年）的結果的啟發，二者同樣側重於數學和自然科學，以及從投入到產出的轉變（最終測試）和根據企業治理的組織形式而導致的學校系統的改變。

關鍵詞：*教育作為第三經濟因素，新數學，在1990年代從投入到產出的轉變，學校的企業治理， 一項創新的更高層次的目標的質疑。*

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Zusammenfassung *(Günter Graumann: Hintergründe und Ziele von ‚Innovationen': Die Beispiele der New Math in den 1960er Jahren und der Wechsel von Input zu Output 1995): Jede Innovation sollte im Sinne einer Humanisierung der Bildung kritisch hinterfragt werden, insbesondere im Hinblick auf den Kontext und die übergeordneten Ziele, für die eine Innovation wirksam sein soll. Dass Innovationen nicht immer Verbesserungen sind, soll an zwei internationalen Beispielen der letzten sechs Jahrzehnte verdeutlicht werden.*

Ausgelöst durch den sogenannten Sputnik-Schock wurde eine Innovation von der OEEC (OECD) in den 1960er Jahren initiiert. Im Interesse der Wirtschaft sollte die Zahl der in Mathematik und Naturwissenschaften ausgebildeten Personen erhöht werden. In diesem Zusammenhang wurde die unter "New Math" bekannte Innovation für den Mathematikunterricht geboren. Eine weitere internationale Innovation setzte Mitte der 1990er Jahre ein und wurde durch die Ergebnisse der vergleichenden OECD-Studien TIMMS (1997) und PISA (seit 2000) angeregt, die ebenfalls auf Mathematik und Naturwissenschaften fokussieren und einen Wechsel von Input zu Output (Abschlusstests) und die Änderung des Schulsystems entsprechend den Organisationsformen der Unternehmensführung zur Folge hatte.

Schlüsselwörter*: Bildung als dritter Wirtschaftsfaktor, New Math, Veränderung von Input zu Output in den 1990er Jahren, Unternehmensführung in der Schule, Infragestellung der übergeordneten Ziele einer Innovation.*

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Аннотация *(Гюнтер Грауманн: Предпосылки и цели «инноваций»: примеры внедрения «новой математики» в шестидесятые годы двадцатого века и операционализации знаний по модели «ввод- вывод»): Концепция гуманизации образования предполагает, что любая инновация должна быть подвергнута критическому рассмотрению, особенно в отношении контекста ее применения и общих целей, в реализации которых и должна помочь инновация. То, что инновации не всегда связаны с улучшениями, наглядно демонстрируют два примера из международной практики, реализованные за последние шестьдесят лет. Запуск советского спутника вызвал шок во всем мире и послужил поводом для «запуска» инноваций со стороны организации экономического сотрудничества и развития. В интересах экономики необходимо было увеличить количество подготовленных специалистов в области математики и естественных наук. Для этих целей была провозглашена инновация под обучение математике, которая получила название «новая математика» (New Math). Другая инновация пришлась на середину девяностых годов двадцатого столетия. Ее «спровоцировали» результаты сравнительных мониторинговых исследований (в 1997 году – TIMMS, начиная с 2000 г. – PISA), инициированных организацией экономического сотрудничества и развития: Эти мониторинги были направлены на «измерение» качества школьного математического и естественнонаучного образования. Они привели к смене дидактической парадигмы (с опорой на принцип выводного знания, использования итоговых тестов) и изменения в системе школьного образования, при которой формы организации занятий должны были копировать принципы управления предприятием.*

Ключевые слова: *образование как третий экономический фактор, новая математика, переход от системы «входа» к принципу выводного знания, внедрение в школьную практику принципов управления предприятием, критическая рефлексия над глобальными целями инноваций.*

Introduction

Innovations in education make an important contribution to the development of education. However, it should always be critically questioned in which direction innovation steers the development and what interest is pursued.

Arthur K. Ellis has provided theoretical foundations for the term "innovations in education", its structures and developments. In a summary of his research on the benefits of innovation, he writes:

> In some instances the evidence is supportive. In others this is not so much the case, especially where shaky theoretical foundations are concerned, few or dubious studies have been conducted, and program evaluation studies are lacking (Ellis, 2005, p. 202).

Elsewhere, he points out that "we have been conditioned by advertisers and promoters to associate 'new' with 'improved', whether the product is a laundry soap or a school curriculum" (Ellis, 2015, p. 6 [PDF Download version; see also: Ellis & Bond, 2016]). To discuss these aspects further, two international top-down innovations will be presented that were pushed by the economy and served less the goals of humanizing education than more political and economic interests.

1. New Math and opening the education system between 1957 and 1972

As part of the trial of strength between the US and USSR on October 4, 1957, the Soviet Union first brought a satellite (Sputnik) into space and thus triggered in the Western world the so-called Sputnik shock. The demand for more and better technical innovations was the result. In the years 1958 to 1961, therefore, the OEEC (Organization for European Economic Co-operation) - the predecessor organization of the OECD (Organization for Economic Cooperation and Development) - stimulated several seminars aimed at improving the teaching of mathematical and scientific subjects and methods. The OECD report on these seminars in 1961 stated amongst others, that the higher economic growth rate is leading to an increased demand for skilled workers who can only be trained in schools. Education is not so much understood as the education of the human being for personality, but education is regarded as an essential, if not decisive, production factor (third factor) in addition to conventional expenditure on labor and capital, which makes economic growth to the required extent possible in the first place (OECD, 1961, p. IV).

At the instigation of this call and the changes in the subject of mathematics, the innovation wave known as "New Math" was developed. An important role was played by Zoltan P. Dienes, secretary of the International Study Group for Mathematics Learning (Sherbroke, Canada) and an expert in mathematics at UNESCO. In his 1960 book "Building up Mathematics", Dienes still pointed to the improvement of the pedagogical situation in mathematics lessons, but in his 1967 book "Approach to modern mathematics", he first emphasized the "need for reform due to economic changes" and under the heading "Which New Kind of Mathematics" he wrote that great demand for other branches of mathematics will exist if industry needs are to be met. For example, the binary system becomes indispensable in arithmetic, because only the binary system can be used satisfactorily for programming in computer language. (Dienes, 1967, p. 17). He also advocated the use of the set-of-speech (i.e. "set-terms", "subsets", "intersection of set" and "union of sets") already from the first school year. About his concept he published a series of books - also with school practical suggestions - and traveled throughout the Western world to promote his ideas.

A related innovation with formal mathematical speech and presentation then was introduced in all western states. In Germany e.g. since 1965, individual experiments have been taken place and in October 1968 the KMK (Conference of the Ministers of Culture of the German Länder) made the decision that from 1972 throughout the Federal Republic the "New Math" is to be taught. In addition to the reference to the "changed way of thinking" in mathematics of the specialists and the reasons for this decision beside others it was put down: "Our economic growth depends on the availability of a sufficient number of mathematically, scientifically and technically well-educated people" (KMK, 1968, p. 1). [Note the expression "available people" - personality is not heard.]

At the same time - with reference to the "third factor of economics" - calls were made in Western Europe for a general opening of the education system. In Germany, the so-called "Picht-Speech" (Picht, 1964), which speaks of a possible coming educational catastrophe, is known for this. And in the OECD report mentioned above, in the foreword to the German edition of 1964 it is stated:

> Today's economic and social conditions demand less from schools the education of an intellectual elite - which always exists - but rather an increase in the educational level of the

> broad masses, whereat insight into the technical, economic and social structure of the modern world of work is necessary (OECD, 1964 [translated by G.G.]).

The result was the admission of more young people to secondary schools and the expansion of the higher education system. In addition, simplified scientific contents were included in primary schools and science-oriented teaching was propagated in pedagogy.

In the early 1970s - after several US astronauts had landed on the moon - the OECD believed that there were sufficient specialists available for technological developments in Western European countries, and especially in the US. For this reason, and also because of the resistance of large sections of the population against "New Math" (see e.g. Kline, 1973), the innovation associated with New Math was reversed and the opening of the education system was stopped by the end of the 1970s. Then in the 1980s, reform pedagogical concepts were used again in the didactics and pedagogy of the subject.

2. Output orientation and management principles in education since 1995

Starting in the mid-1990s, a new top-down innovation was introduced in Europe by the OECD. The background to this was again the reference to the third factor of economics, namely the educational level of most member states in reading, literacy, mathematics and science. The comparative studies TIMSS (Third International Mathematics and Science Study / since 2003 called: Trends in International Mathematics and Science Study) carried out by the OECD 1995 and the PISA studies (Program for International Student Assessment) from 2000 onwards showed differences, especially compared with Asian countries. In Germany in particular, the results of the TIMS-Study have been the subject of intense discussions among educators, but barely were noticed by the general public. However, apart from a few exceptions, it was the first performance review with standardized methods at the international level in which Germany participated. Some authors (e.g. Klieme & Baumert, 2001) noted that

> Education policy and the public in Germany have insufficient information on the framework conditions, process characteristics and effects of the education system at supra-regional and national level. To date, there has been no regular investigation and statistical analysis of the effectiveness of our education system. In the USA, however, in the Netherlands and now also in Great Britain and the Scandinavian countries, such a system of monitoring is firmly anchored. It serves educational policy and schools as a feedback and early warning system (ibid., p. 5 [translated from German by G.G.]).

And Röhner (2009) drew attention to the fact that

> With the OECD's measure of international comparisons of school performance, national education systems will have to examine the extent to which children and young people are prepared for the challenges of the knowledge society by means of international comparisons. The driving force behind this development is not exclusively a pedagogical one, but increasingly also an economic one, which wants to ensure the international competitiveness of states and communities (ibid., p. 11 [translated from German by G.G.]).

In contrast to TIMSS, the PISA study received much more attention. Some of the features of PISA are very different from previous school performance like assessments to accumulation of knowledge, special ability training and so-called competences "relevant to personal, social and economic well-being". As stated 1999 by the OECD its contractual task is policy advice and PISA should not only provide a description of the actual state, but also trigger improvements. To the extent that PISA is

based on its own educational concept, it at least implicitly claims to have a retroactive effect on national curricula (PISA-Studien, 2019).

In Germany, curricula have been changed since 2003 to focus on the acquisition of competences. The entire pedagogical discussion changed because the focus was no longer on "input" (pedagogical objectives and methodological considerations) but on "output" (final test at various levels), which also created a competitive mindset between different schools. In the process, school management was induced to adopt organizational forms of corporate governance. Instruction was often shortened to the preparation of the tests, leaving only content and competencies to be considered through written tests.

All in all, an empirical turn in pedagogy away from a rather humanistic orientation towards empirical research with comparative studies and final examinations took place as a focus. However, due to educational tendencies oriented towards business thinking and comparative and output tests, such a concept is considerably reduced and stunted to learning only testable knowledge, skills and abilities - a bad traditional teaching in a new one garb. In addition, publicly funded research has recently been followed this test trend to a considerable extent. That for other research directions and fundings often no money is available. A report by G. Lind e.g. on the results of the 2002 'no-child-left-behind' law in the US does show this (Graumann, 2009, p. 65 f.).

3. Concluding remark

If we now assess this still prevailing trend from a pedagogical point of view, we can conclude, as we did in the innovation of the 1960s that despite some positive results (e.g. the suggestion to reflect on learning goals), the aspect of humanizing education has been lost sight of. It should not be denied that young people also have to acquire knowledge and skills relevant to everyday life and work, but the individual development of personality and the promotion of general cultural knowledge and skills as well as especially democratic attitudes should not be lost.

Through bottom-up innovations, a turn towards the humanization of education must be initiated. Whether the recent proposals to digitize the teaching can help in this is very questionable. In any case, every innovation has to be critically examined in terms of its background and what goals are achieved or supported.

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