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An attempt to optimise the number of pupils in comprehensive secondary schools based on their learning outcomes

Abstract

Research background: There may be a significant correlation between the number of pupils in a school and their learning performance. Some studies point to the negative impact of schools with a large number of pupils on the educational results achieved. At the same time, the demographic crisis that has been deepening steadily for several years now represents an important motivation for rationalising the existing network of schools.

Purpose of the article: The aim of the study was to determine the optimum size of schools based on the criterion of examination results expressed through educational value added.

Methodology/methods: The analysis covered all comprehensive secondary schools in Poland over the 2013 to 2015 period (a total of 1,943 schools). It determined the correlation between the size of a school expressed through the average number of graduates, and the results of the matura examination (the secondary school leaving exam in Poland) expressed through educational value added. Data for the analysis was obtained from the Section of Educational Value Added of the Educational Research Institute in Warsaw. The comprehensive secondary schools under study were divided into 5 classes, according to the criterion of the average annual number of graduates. The following analytical classes were distinguished: class A - up to 50 graduates, class B - 51-100 graduates, class C - 101-150 graduates, class D - 151 -200 graduates, class E - above 201 graduates.

Findings: The analyses conducted in this study showed that the comprehensive secondary schools with over 600 pupils had the highest learning outcomes as expressed through educational value added. The lowest educational effectiveness was found in schools with less than 150 pupils. A dependency was discovered whereby the effectiveness of education increases as the number of pupils grows. Due to the lack of data concerning examination results in schools with more than 1,000 pupils (value indicated in American studies as the threshold value for positive learning outcomes), it was not possible to determine the maximum number of pupils that guarantees satisfactory learning outcomes.

Introduction

The key question to be asked when evaluating the effectiveness of educational facilities concerns the learning outcomes. Moreover, the public spending on education in Poland amounts to about 6% GDP. Such an amount of spending provides a particularly strong argument for seeking the ways to rationalise the expenditure allocated to this area of public activity.

The question seems even more relevant in view of the deepening demographic crisis. This is directly related to the issue of the optimum school size that would ensure the desirable learning environment and simultaneously minimise the administrative costs of running an educational facility.

The problem of school size should be considered in relation to the educational stage, since the negative impact of school size on learning outcomes may be linked to a particular stage of education.

In view of those considerations, the question should be asked: How big should a school be in order to ensure the optimum learning outcomes? Based on that question, the research objectives of this article were formulated. Thus, the purpose of the study was to determine the optimum size of a school based on the criterion of examination results expressed through educational value added.

The priority goal of educational activity should be to achieve the highest quality of education possible in a given situation. This objective was also confirmed by the report of the Polish Supreme Audit Office: "*The Supreme Audit Office regards the quality of school education as one of the most important long-term factors affecting the development of the state and the living standard of its citizens*" (NIK, 2014, p.7). Bearing this in mind, any measures aimed at rationalising the network of education facilities should take into account the effect of that rationalisation on learning outcomes.

Method of the research

The data in this study was analysed on the basis of the 3-year (2013-2015) educational value added indicator for all comprehensive secondary schools in Poland (N=1,943). Data for the analysis was obtained from the Section of Educational Value Added of the Educational Research Institute in Warsaw.

The comprehensive secondary schools under study were grouped into 5 classes according to the average number of graduates per each year of analysis: class A (up to 50 graduates), class B (51-100 graduates), class C (101-150 graduates), class D (151-200 graduates), and class E (above 250 graduates). Based on the quantitative analysis of educational value added in comprehensive secondary schools, the percentage of schools with a positive and negative educational value added indicator was determined for the examined population. Moreover, the mean educational value added indicator was calculated for each class of comprehensive secondary schools defined by the average annual number of graduates.

The impact of pupil number in a school on learning outcomes

The structure and quality of school environment is generally considered to be vital for creating favourable learning conditions and encouraging parental involvement. It is believed that large, impersonal and highly bureaucratised schools create many barriers to effective learning (Meier, 1997, pp. 194-208). Case studies investigating the effectiveness of schools point to the importance of school size (Hunt, 1990, pp. 252-254). At the same time, an improvement in pupils' educational attainment was observed in small comprehensive secondary schools (Darling-Hammond et al., 2002, pp. 639-673).

It is a popular belief that pupils attending smaller schools achieve better learning outcomes. In particular, attention is drawn to better learning conditions in those schools. A study conducted in New York took into account interpersonal relationships, educational outcomes, social attitudes and the level of safety. The results of the study suggest that the pupils attending a small school perceive it as a better learning environment needed for the accomplishment of their own objectives. However, the studies cited above did not substantiate the thesis that small schools provide a better learning environment than large ones. The findings represent a challenge for the widespread belief that better conditions offered by small schools contribute to higher learning outcomes(Schwartz et al., 2016, pp. 272-290)

The research on the optimum size of schools yields varied results. A study on educational value added conducted in North Carolina pointed to the lack of cause/effect relationship between school size and the learning outcomes achieved by the pupils. It was noted, however, that school size plays an important role for disabled pupils (Gershenson & Langbein, 2015, pp.135S-155S).

Some research findings suggest that the proper pupil/teacher ratio is an important factor reducing the level of crime. However, those parameters are not linked to school size. The level of crime amongst pupils is to a greater degree determined by the social capital derived from their family background than by the actual school size (Gottfredson & DiPietro, 2011, pp. 69-89).

The studies discussed above refer to a completely different part of the world. However, similar studies were also conducted in Ukraine, a country that is geographically close to Poland. The Ukrainian studies highlight the need to rationalise the school network due to demographic decline. In this context, a question arises. Should we maintain smaller schools and expect better exam results? Independent tests revealed that school size has a relatively small impact on the learning outcomes in secondary schools. This observation provides an argument in favour of rationalising the network of schools (Coupe et al., 2016, pp. 329-351).

The US government recommended the consolidation of schools, especially in rural areas, in order to improve school effectiveness. However, this policy was criticised. It was argued that school consolidation would result in the deterioration of learning conditions. Moreover, such situations usually raise questions concerning the economies of scales. One of the arguments in favour of school consolidation are the savings resulting from reduced costs of administration due to the transfer of schools with less than 500 pupils to the districts that provide schooling for about 3,000 to 4,000 pupils. This solution, however, goes contrary to the conclusions of studies on educational production function. The studies advocate maintaining primary schools with 300-500 pupils and secondary schools with 500-900 pupils. The authors of those studies believe that such school sizes could balance the advantages arising from the school size with the potential negative effects of large schools(Andrews et al., 2002, pp.245-262).

In Chicago, research on the size of comprehensive secondary schools was conducted over four years in order to assess the impact of transformation of large, traditional schools into small, autonomous ones. It was shown that the analysed schools had a lower drop-out rate. The authors of the study did not find any strong arguments to justify school size reduction,

which implies there is no correlation between school size and learning outcomes(Kahne et al., 2008, pp. 281-315).

An examination of 57 results of empirical school size research carried out in the USA after 1990 reveals that primary schools for pupils from socially and economically disadvantaged backgrounds should ideally be limited in size to 300 pupils. Primary schools for pupils from advantaged backgrounds should be limited in size to 500 pupils. The size of middle schools should be limited to 600 pupils, whereas secondary school serving youth from socially and economically diverse backgrounds and relatively advantaged backgrounds should not exceed 1,000 pupils(Leithwood & Jantzi, 2009, pp. 464-490).

Other studies investigating the relationship between school size and learning achievements show that a comprehensive secondary school should ideally serve between 600-900 pupils. Pupils in smaller schools demonstrated lower academic performance; a similar situation was observed in schools serving over 2,100 pupils. It should be noted that the educational process was found to be more equitable in very small schools where it was linked to the pupil's socio-economic status (Lee & Smith, 1997, pp. 205-227).

The size of comprehensive secondary schools in Poland and learning outcomes

The mean educational value added provides an objective measure of school effectiveness. It is calculated for each pupil separately and the sum of scores of that indicator can be used to evaluate a school's effectiveness. The desired score of that indicator should be a positive value (neutral value is expressed through zero). A negative educational value added means that the teaching process does not make the proper use of the pupils' educational level. The assumptions concerning educational value added were used to estimate the effectiveness of schools depending on the school size which, in the present study, was expressed through the average annual number of graduates during the research period.

Table 1. Synthetic summary of matura exam results in comprehensive secondary schools from 2013-to 2015

Number of pupils taking matura exam (Class)	Polish language			Humanities		
	Number of schools with negative EVA	Number of schools with negative EVA	Mean EVA	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA
≤ 50 (A)	250 (30.34%)	574 (69.66%)	-2.09229	237 (28.76%)	587 (71.24%)	-2.29663
51-100 (B)	128 (32.24%)	269 (67.75%)	-1.32224	114 (28.72%)	283 (71.28%)	-1.52058
101-150 (C)	154 (49.68%)	156 (50.32%)	-0.07465	153 (49.35%)	157 (50.65%)	-0.05903
151-200 (D)	**170 (65.63%)**	**89 (34.36%)**	**0.79297**	**174 (67.18%)**	**85 (32.82%)**	**0.93170**
≥201 (E)	**111 (72.55%)**	**42 (27.45%)**	**1.53915**	**115 (75.16%)**	**38 (24.84%)**	**1.68386**
Number of pupils taking matura exam (Class)	Mathematics			Mathematical and natural sciences		
	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA	Number of schools with positive EVA	Number of schools with negative EVA	Mean EVA
≤ 50 (A)	150 (18.20%)	674 (81.79%)	-3.49010	149 (18.08%)	675 (81.92%)	-3.87027
51-100 (B)	110 (22.71%)	287 (72.29%)	-2.02076	103 (25.94%)	294 (74.06%)	-2.33627
101-150 (C)	164 (52.90%)	146 (47.10%)	0.07616	168 (54.19%)	142 (45.81%)	0.05806
151-200 (D)	**189 (72.97%)**	**70 (27.03%)**	**1.54958**	**202 (77.99%)**	**57 (22.01%)**	**1.70452**
≥201 (E)	**124 (81.05%)**	**29 (18.95%)**	**1.91778**	**131 (85.62%)**	**22 (14.38%)**	**2.25196**

Source: own work based on the data from the Educational Research Institute.

An evaluation of school effectiveness on the basis of educational value added indicator shows that the schools with the smallest number of graduates (class A and B) have an undesired level of learning outcomes. This is evidenced by the relatively high percentage of schools with negative educational value added and negative mean educational value added. In class A, about 70% to approximately 82% schools had a negative value added score. In class B, there were about 68% to74% such schools. A similar correlation was found with respect to mean educational value added which oscillated between -3.49010 and -1.32224 in the two classes mentioned above (Table 1).

The data given in Table 1 suggests that a school's effectiveness increases as the number of pupils in the school increases. A limit of 101-150 graduates represents the threshold value between ineffective and effective educational process. An analysis of final examination results in schools with such a number of graduates reveals that 50% of schools from that group

(class C) have positive educational value added score. Moreover, mean educational value added has a positive score for examination results in mathematics, and mathematical and natural sciences (Table 1).

The vast majority of schools in the next two classes, i.e.class D (151 graduates) and class E (above 201 graduates), achieved a positive educational value added score. About 65% of schools in class D had a positive educational value added for Polish language exams, and over 85% of schools achieved a positive value added for mathematical and natural sciences exams (Table 1). Moreover, both those classes of schools recorded a regular increase in mean educational value added. The increase was from 0.79297 for Polish language exams in class D to 2.25196 for mathematical and natural sciences exams in class E (Table 1).
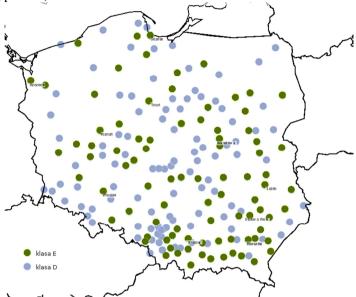
The three-year education cycle in Polish comprehensive secondary schools permits the following estimation of the number of pupils in a school: up to 150 in class A, from 151 to 300 in class B, from 301 to 450 in class C, from 451 to 600 in class D, and above 600 in class E. Under Polish conditions, it should be assumed that an effective learning environment is provided by schools serving a minimum of 450 pupils. However, schools with more than 600 pupils achieve even better learning outcomes. The proposed school sizes are in line with the results of the American studies quoted above (Leithwood & Jantzi, 2009, pp.464-490; Lee & Smith, 1997, pp. 205-227; Andrews et al., 2002, pp. 245-262).

A spatial analysis of the distribution of classes with the highest learning outcomes (D and E) shows that the schools belonging to those classes are usually located in large agglomerations, or cities. Such a correlation may indicate the presence of additional factors that strongly affect the quality of educational processes and have a particularly beneficial effect on those processes in large urban centres.

In this context, one cannot overlook the importance of what social scientists refer to as reproduction processes. Those processes are related to the phenomenon of *habitus* which is understood as a set of trends, dispositions, perceptions of values, and attitudes reflected in human habits (Bourdieu & Passeron, 2006, p. 13).

Special attention is given to the process of educational selections and the associated membership in the social class of origin which determines the living standards, the ethos as well as the hereditary social and cultural capital(Bourdieu & Passeron, 2006, p. 25).

Figure 1. Distribution of schools belonging to class D and E (the most effective teaching process)

Source: own work based on the analysed data.

Problems that may be attributable to young people's social and cultural capital were also confirmed by the report drawn up by the Supreme Audit Office, according to which *"pupils in middle and secondary-school show low motivation for participation in school activities which, alongside behavioural issues, leads to deterioration in pupils' learning outcomes. The pupils surveyed by the Supreme Audit Office reported that they would achieve better learning results if the teachers could get them interested in their subject"*(NIK, 2014, .9).

Conclusions

The analyses conducted in this study showed that the comprehensive secondary schools with over 600 pupils were characterised by the highest learning outcomes as expressed through educational value added. Those findings have also been confirmed by the American studies quoted above.

The dependencies discovered in this study may provide guidance to local government bodies (poviats) concerning the development of school network, especially in the context of demographic decline. It should be remembered, however, that the effectiveness of teaching does not solely

depend on the number of pupils in school, but is also affected by other factors belonging to the sphere of sociocultural capital and economic capital.

Nonetheless, the analyses investigating all comprehensive secondary schools in Poland over a 3-year research period revealed that the school size has no negative impact on the quality of teaching (on the contrary, positive impact was identified), which is a sufficiently strong conclusion to be considered when undertaking the modification of the existing school network.

Due to the lack of data concerning examination results in schools with more than 1,000 pupils (number indicated in American studies as the threshold value for positive learning outcomes), it was not possible to determine the maximum number of pupils in a school that would guarantee satisfactory learning outcomes (Leithwood & Jantzi, 2009, pp. 464-490).

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