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JAN POLCYN
BAZYLI CZYŻEWSKI

Maximizing the quality of education by measuring the educational added value in secondary school technical type on the basis of exam results

1. Introduction

The most important factors that determine the economics of education include the number of educational institutions maintained and the quality of human capital created by them, expressed most often as examination results. From a budgetary point of view, combining these two values requires taking optimization measures.

The ongoing demographic decline in Poland leads to a lower student intake, which results in the reduced number of students in schools and raises questions about rationality in the functioning of the current network of schools. It is difficult to examine this rationality in Poland due to the absence of standards for costs incurred in the implementation of curricula in accordance with applicable state law (Kowalska 2012, p. 138). Nevertheless, rationality in the functioning of the school network remains an essential problem for local government units. It is particularly important in the case of secondary vocational schools, because their performance determines whether the skills

Jan Polcyn, Ph.D.
Stanisław Staszic University of Applied Sciences in Piła
Prof. Bazyli Czyżewski
Poznań University of Economics

of the middle-level personnel meet the needs of the labour market (Przekota 2011, pp. 171-191; Przekota 2013, pp. 148-162).

It seems that simple analysis, based on the examination of curricula implemented in secondary vocational schools, would indicate that this type of education is much more expensive than general school education at the same level. However, it turns out that while this tendency exists in most European Union countries, it is quite the opposite in Poland. According to the OECD, the average cost of annual education in a general secondary school is USD 5,709 per student per year, while in a secondary vocational school, it is USD 5,376 (Sztanderska and Drogosz-Zabłocka 2013, p. 7).

The rationale for this study is to find a way to optimize expenditures on secondary vocational education. Optimization measures should lead to the creation of high-quality human capital. Part of society believes that since we already have a certain material infrastructure and qualified staff, we should maintain small schools to improve the quality of education. However – as shown later in this paper based on the literature review – it is not clear whether small schools ensure high quality of education.

The reasons cited above have been used to determine the objective of this paper, which is to verify the view indicating that schools with fewer students achieve better educational outcomes.

2. Measuring the effects of education: educational value added

One of the criteria for assessing the quality of education is the assessment of examination results attained by students. These results are often used to develop school ranking tables. However students' outcomes can largely be dependent on the earlier stages of their education, family situation and social capital. If school ranking tables neglect the above factors and take into account only 'raw' test scores, the assessments of schools contain fundamental errors. These are the most important reasons for introducing the educational value-added measure to the evaluation of the quality of schools (Gorard 2006, 235-243).

In theoretical terms, the idea of educational value added is based on the assumption that schools can contribute to improving the quality of education by eliminating the influence of family and social environment on students (Mortimore et al. 1994, pp. 315-332). It is assumed that learners tend to function in the same environment, while the educational value added is determined by modelling their achievements in the directly lower and higher stages of education. Despite the fact that the educational value-added measure assumes the elimination of external factors affecting the quality of education from the evaluation of schools, some studies indicate the importance of factors modifying the educational value added, such as the level of poverty determined by the proportion of students entitled to free school meals (Thomas and Mortimore 1996, pp. 5-33). A study on different value-added modelling methods conducted in Dutch schools shows that there is a very high correlation between different types of educational results in individual schools. The basic factor modifying the educational value added in schools covered by the study was characteristics resulting from the social composition of student populations (Timmermans et al. 2011, pp. 393-413). The impact of student composition on the schools' value-added performance was particularly strongly correlated with students' levels of education. This relationship has been confirmed in the Netherlands, Belgium, Chile, Australia, the USA and the UK (Timmermans and Thomas 2015, pp. 487-498). In Poland, the socio-economic determinants of schools' value-added performance were studied by Czyżewski and Brelik, among other authors (Czyżewski and Brelik 2016, pp. 93-104).

The idea of educational value added under Polish conditions involves comparing external exam results (test scores) – conducted by Regional Examination Boards – achieved in the early stage of education with the results of similar examinations attained in the next stage of education. In Poland, examination results obtained in middle schools are compared with final exam results attained in secondary schools (Dolata 2007, p. 9). The educational value added indicator is calculated as an aggregate measure – it takes into account the examination results of groups of students and is then interpreted as a measure of the average contribution of school or teacher. The indicator estimates the impact of school or teacher on the groups of students under study. The value-added performance of a group of students is determined by comparing their exam results with other variables, such as the outcomes of other students having similar individual features and learning under similar conditions. In summary, educational value-added modelling determines to what extent specific examination results were higher or lower than the expected scores for the group of students under analysis (Żółtak 2015, p. 9).

3. The number of students in schools and their learning outcomes

Some studies show that despite the positive attitudes of teachers and their full involvement in the teaching process, better learning outcomes are obtained in small schools than in large schools (Lee and Loeb 2000, pp. 3-31). It is emphasized, however, that under American conditions teaching was most effective in medium-sized school, i.e. with 600-900 students, less effective in small schools and the least effective in large schools, i.e. with more than 2,100 students (Lee and Smith 1997, pp. 205-227).

Low numbers of students in schools may be beneficial to learners due to the school climate and the impact of teachers. Studies show that converting large schools into smaller ones does not always result in the expected results. Therefore, the examination results of students are used to assess what school size is most beneficial in terms of educational outcomes (Werblow et al. 2010, pp. 191-208).

The above research results, however, have not been confirmed by other studies. For example, a study conducted in the United States demonstrates that teaching was more effective in large schools (Stevenson 2006, pp. 1-7).

Research on the effectiveness of teaching and learning processes most often focuses on socio-economic status and the participation of ethnic minorities. In some studies, these factors significantly influenced students' performance, while school size or the ratio of pupils to teachers did not have a significant impact on these results (Caldas 1993, pp. 206-2014). A study was carried out in Denmark on the long-term effects of school size on students' outcomes, expressed in the percentage of graduates and their earnings at the age of 30. The researchers have concluded that small schools are especially beneficial to young learners from families with a low educational level (Humlum and Smith 2015, pp. 28-43).

A study on school size conducted in the Netherlands is strongly correlated with the governmental policy on primary and secondary schools. The study may contribute to an increase in school size, leading to more rational spending on school equipment and increased professionalization and specialization of teachers (Luyten et al. 2014, pp. 1-227).

4. The research method

Nine classes were selected from a group of all secondary technical schools in Poland (N = 1683). Each class consisted of 20 schools selected by the average annual number of graduates in 2013-2015. Class A included schools having on average no more than 20 graduates, Class B: 21-40, Class C: 41-60, Class D: 61-80, Class E: 81-100, Class F: 101- 120, Class G: 121-140, Class H: 141-160 and Class I: 161-180 graduates. Thus, the study sample consisted of 180 secondary technical schools. Twenty schools having values closest to the median value of the average annual number of graduates were selected from each class of secondary technical schools consisting of more than 20 schools.

A univariate analysis of variance ANOVA was then carried out. The dependent variables were the mean educational value added of final examinations in Polish language, the humanities, mathematics and natural sciences. Classes determined by the average number of graduates were the quality predictor in this analysis.

Multivariate significance tests were conducted, including Wilks, Pillai, Hotelling and Roy, to accept the null hypothesis that the vectors of educational value added for secondary technical school graduates are equal, or to adopt the alternative hypothesis that they are significantly different.

A post-hoc analysis was then carried out using the Tukey HSD test for relevant dependent variables (according to univariate results) to evaluate what quality predictor classes significantly determine the variation of the dependent variables. Subsequently, contrasts were determined for quality predictor classes to identify what part of variation can be attributed to a particular contrast. The sum of squares (SS), or variations attributed to contrasts, was calculated according to formula 1 and divided by the SS for the dependent variable in each predictor class (Stanisz 2007, p. 367):

$$SS_L = \frac{\overline{L}^2}{\frac{1}{n}\sum_{i=1}^{k} c_i^2} \tag{1}$$

where:

$\overline{L}$ - contrast;

n – the number of replications (measurements per group);

c_i – weights describing a contrast.

Contrasts were determined by formula 2:

$$\overline{L} = \sum_{i=1}^{k} c_i \overline{x}_i \text{ , where } \overline{x}_1, \ldots, \overline{x}_k \text{ , are sample means} \tag{2}$$

In the last stage of the analysis, the so-called indicator ω was calculated. Indicator ω is an estimator of the variance of the dependent variable explained by the independent variable for the number of graduates (as relevant dependent variables). Indicator ω was determined by formula 3 (Stanisz, 2007, p. 367 et seq.):

$$\omega = \frac{(SS_{effect} - p \cdot MS_{error})}{SS_{effect} + SS_{error} + MS_{error}} \tag{3}$$

where:

- SS_{effect} – the between-class sum of squared differences between the means of variables for each predictor class and their grand mean (the total variation of all means);
- p – degrees of freedom due to prediction;
- SS_{error} – random variation, i.e. the sum of squared differences between the results of the observation and the mean value for a class;
- MS_{error} – mean sums of squared errors.

Indicator ω is used to estimate what percentage of variance of each dependent variable is attributed to the quality predictor; in this case, it is the number of secondary technical school graduates.

5. The number of students and the mean educational value added in secondary technical schools

The mean educational value added in Polish language does not show a clear trend, but it can be assumed that educational value added scores in Polish language are growing. The highest value was found in Class H (141-160 graduates). Assuming a four-year learning period in a secondary technical school, this gives the estimated school size ranging from 564 to 600 students (figure 1). Schools of this size are close to schools characterized by the greatest teaching effectiveness described in the American study cited above (Lee and Smith 1997, 205-227). A clear decline in the educational value added was observed in Class I, which consists of schools having from 161 to 180 graduates, which corresponds to the number of students in schools ranging from 644 to 720 graduates (figure 1). However, further analysis of contrasts for the educational value added showed no statistically significant differences between the classes determined by the number of graduates (figure 2).

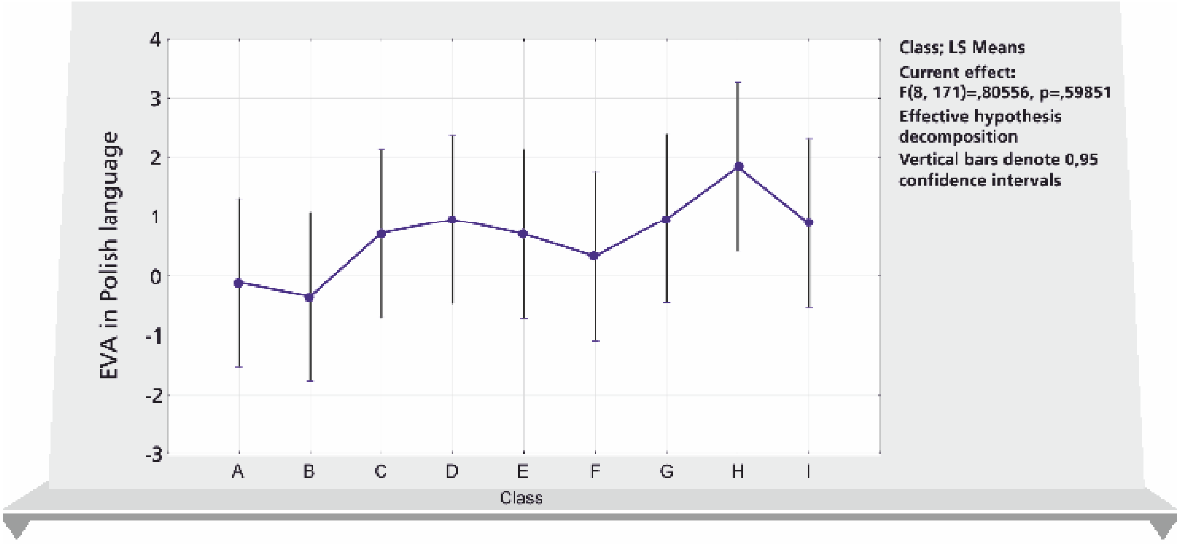

Figure 1. Dependence of the educational value added in Polish language on school size

Source: own study based on the data studied

The analysis of the mean educational value added in mathematics between classes of schools determined by the number of graduates shows a clear increase

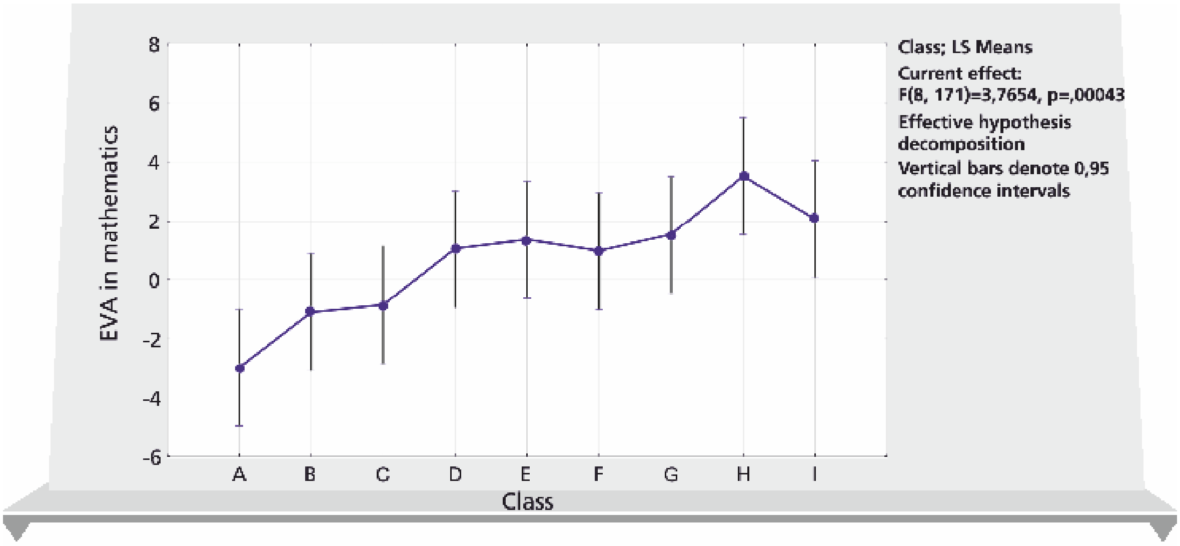

Figure 2. Dependence of the educational value added in mathematics on school size

Source: own study based on the data studied

in this value from Class A to Class H. A significant decrease in the educational value added was observed in Class I (figure 2). These dependencies show that this trend is similar to the one observed in the case of Polish language. In addition, statistically significant differences in the educational value added were found between the classes (table 2).

The trends observed in the case of the mean educational value added in natural sciences were similar to those in mathematics (figures 2 and 3). The insignificant differences between these mean values may stem from the fact that the mean educational value added in natural sciences is determined to a large extent by the educational value added in mathematics, which constitutes an important part of natural sciences. Statistically significant differences between the classes were found in both the mean educational value added in mathematics and the mean educational value added in natural sciences (table 2).

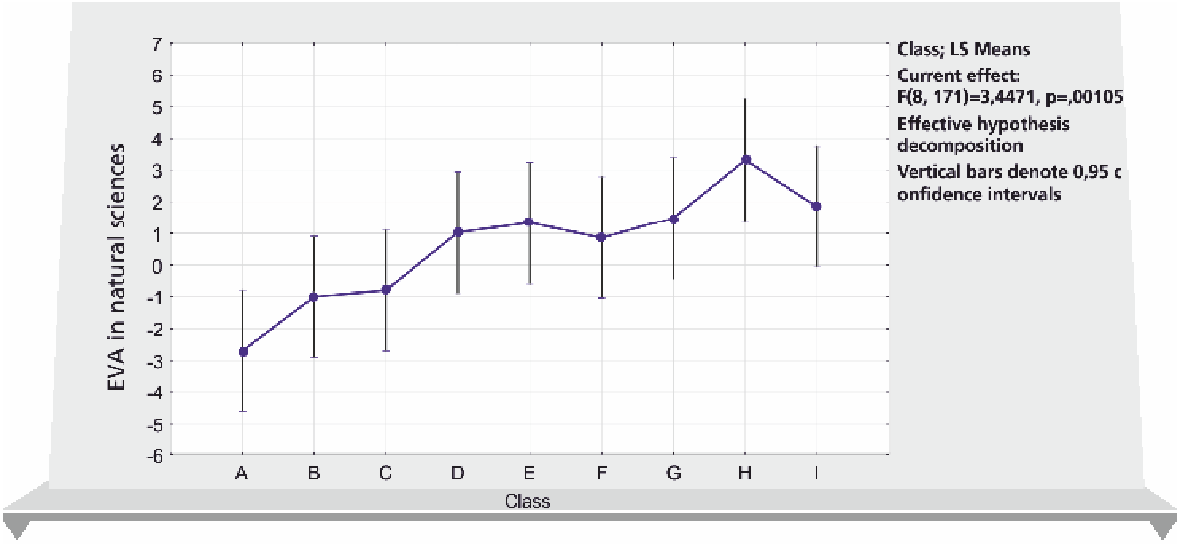

Figure 3. Dependence of the educational value added in mathematics and natural sciences on school size

Source: own study based on the data studied

A similar correlation between the classes of schools in terms of the mean educational value added in the humanities was found with respect to Polish language (figures 1 and 4). It is assumed that this similarity is due to the inclusion of the mean educational value added in this measure. The exam in Polish language is compulsory for all graduates, while exams in the other subjects belonging to the humanities are optional for students in Poland. In addition, it should be noted that there were no statistically significant differences between the classes determined by the number of graduates and the mean educational value added in the humanities (table 2).

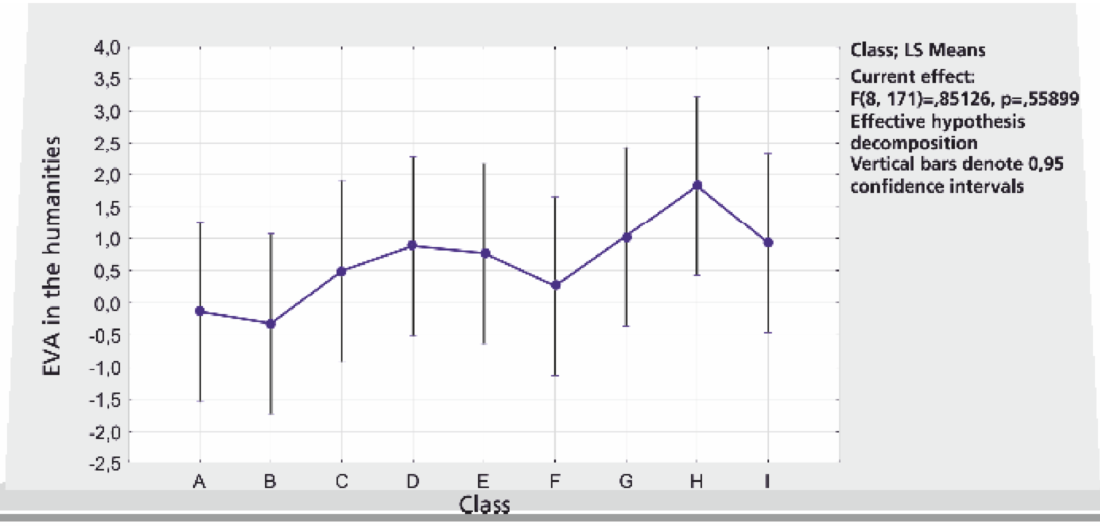

Figure 4. Dependence of the educational value added in the humanities on school size

Source: own study based on the data studied

The multivariate significance tests reject the null hypothesis that the vectors of the mean educational value added are equal and indicate that these values are significantly different, as confirmed by further considerations (table 1).

Table 1. Multivariate tests of significance

	Test	Value	F	df_{effect}	df_{error}	p
Classes by the number of students in schools	Wilks	**0.002**	**58.38**	**40**	**730.7306**	**0.00**
	Pillai	**1.096**	**6.00**	**40**	**855.0000**	**0.00**
	Hotelling	**468.179**	**1935.92**	**40**	**827.0000**	**0.00**
	Roy	**468.077**	**10005.15**	**8**	**171.0000**	**0.00**

Source: own study based on the data studied

The univariate results indicate a significant variation of two variables, i.e. the mean educational value added in mathematics and the mean educational value added in natural sciences. There were no significant differences between the classes determined by the number of graduates and the mean educational value added in Polish language and in natural sciences (table 2).

Table 2. Univariate results for the dependent variables

	Scores	EVA in Polish language				EVA in mathematics			
		SS	MS	F	p	SS	MS	F	p
Classes by the number of students in schools	8	67.10	8.388	0.8056	0.5986	**601.60**	**75.200**	**3.7654**	**0.0004**
Error	171	1780.51	10.412			3415.05	19.971		
Total	179	1847.61				4016.65			
		EVA in natural sciences				**EVA in the humanities**			
Classes by the number of students in schools	8	**516.52**	**64.565**	**3.4471**	**0.0010**	68.42	8.553	0.8513	0.5590
Error	171	3202.86	18.730			1718.02	10.047		
Total	179	3719.38				1786.44			

Source: own study based on the data studied

These dependencies indicate that further analysis should focus on the mean educational value added in mathematics and in natural sciences (table 2).

The post-hoc tests show that changing school size from Class A to Class G, H or I is significant for the mean educational value added in mathematics (table 3). This correlation indicates that teaching does not need to be more effective in small schools (Werblow et al. 2010, pp. 191-208). In this study, each school belonging to Class A had up to 20 graduates, so the whole school had about 80 students. It may be supposed that the existence of such small technical schools is justified in school complexes; however, it was not possible to verify this thesis in this study. Schools with the highest mean educational value added had from 484 to 720 students. Thus, the opinion that teaching is more effective in large schools has been confirmed (Stevenson 2006, pp. 1-7).

Table 3. Tukey HSD test – the variable: educational value added in mathematics

Tukey HSD test; the variable: EVA in mathematics (Data_T_2013-2015); approximate probabilities for post-hoc tests; error: between-class MS = 19.971, df = 171.00										
No.	Classes by the number of students in schools	A	B	C	D	E	F	G	H	I
1.	A		0.9264	0.8573	0.1043	0.0577	0.1193	**0.0393**	**0.0002**	**0.0111**
2.	B	0.9264		1.0000	0.8460	0.7243	0.8702	0.6391	**0.0305**	0.3773
3.	C	0.8573	1.0000		0.9189	0.8286	0.9349	0.7567	0.0529	0.4984
4.	D	0.1043	0.8460	0.9189		1.0000	1.0000	0.9999	0.7207	0.9985
5.	E	0.0576	0.7243	0.8286	1.0000		0.9999	1.0000	0.8433	0.9999
6.	F	0.1193	0.8702	0.9349	1.0000	0.9999		0.9999	0.6865	0.9975
7.	G	**0.0393**	0.6391	0.7567	0.9999	1.0000	0.9999		0.8986	0.9999
8.	H	**0.0002**	**0.0305**	0.0529	0.7207	0.8433	0.6864	0.8986		0.9842
9.	I	**0.0111**	0.3773	0.4984	0.9985	0.9999	0.9975	0.9999	0.9842	

Source: own study based on the data studied

The post-hoc tests also indicate that there are strong grounds for changing classes from A to H, i.e. from schools with 20 graduates to schools ranging from 161 to 180 graduates (table 3).

The post-hoc tests show that changing school size from Class A to H or I, and from Class B to Class H is significant for the mean educational value added in natural sciences (table 4). These findings largely confirm the dependencies observed for the mean educational value added in mathematics (table 3).

The analysis of contrasts carried out between classes where the mean educational value added in mathematics differed significantly shows that changing school size from Class A (up to 20 graduates) to Class I (161-180 graduates) explains 52% of differences in the mean educational value added. Significant differences in the mean values were also found between Class B (21-40 graduates per year) and Class I – contrasts explain 21% of differences in the mean educational value added (table 5). Indicator ω for contrasts was 0.11, meaning that the classes of schools determined by the number of graduates explain as few as 11% of differences in the mean educational value added between the classes.

Table 4. Tukey HSD test – the variable: educational value added in natural sciences

Tukey HSD test; the variable: EVA in natural sciences (Dane_T_2013-2015); approximate probabilities for post-hoc tests; error: between-class MS = 18.730, df = 171.00										
No.	**Classes by the number of stu-dents in schools**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
1.	A		0.9481	0.9013	0.1402	0.0793	0.1877	0.0569	**0.0004**	**0.0254**
2.	B	0.9481		1.0000	0.8637	0.7453	0.9131	0.6693	**0.0433**	0.4864
3.	C	0.9013	1.0000		0.9227	0.8323	0.9557	0.7677	0.0680	0.5947
4.	D	0.1402	0.8637	0.9227		1.0000	1.0000	0.9999	0.7672	0.9996
5.	E	0.0793	0.7453	0.8323	1.0000		0.9999	1.0000	0.8794	0.9999
6.	F	0.1877	0.9131	0.9557	1.0000	0.9999		0.9999	0.6884	0.9985
7.	G	0.0570	0.6693	0.7677	0.9999	1.0000	0.9999		0.9225	0.9999
8.	H	**0.0004**	**0.0433**	0.0680	0.7672	0.8794	0.6884	0.9225		0.9786
9.	I	**0.0254**	0.4864	0.5947	0.9996	0.9999	0.9985	0.9999	0.9786	

Source: own study based on the data studied

Table 5. Evaluation of contrasts for the variable: educational value added in mathematics

	EVA in mathematics					
	Scores	SE	t	p	CL -95.00%	CL +95.00%
CONTRAST 1 (A vs. I, i.e. 1;0;0;0;0;0;0;0;-1)	**-5.0325**	**1.41319**	**-3.561**	**0.0004**	**-7.822**	**-2.242**
*$SS_{contrast}/SS_{effect}$	**0.42 (52%)**					
CONTRAST 2 (B vs. I, i.e. 0;1;0;0;0;0;0;0;-1)	**-3.1705**	**1.41319**	**-2.244**	**0.0261**	**-5.960**	**-0.380**
*$SS_{contrast}/SS_{effect}$	**0.17 (21%)**					
CONTRAST 3 (C vs. I, e.g. 0;0;1;0;0;0;0;0;-1)	-2.9165	1.41319	-2.064	0.0405	-5.706	-0.126
*$SS_{contrast}/SS_{effect}$	0.14 (17%)					
CONTRAST 4 (D vs. I, e.g. 0;0;0;1;0;0;0;0;-1)	-1.0210	1.41319	-0.722	0.4709	-3.810	1.768
*$SS_{contrast}/SS_{effect}$	0.02 (2%)					
CONTRAST 5 (E vs. I, e.g. 0;0;0;0;1;0;0;0;-1)	-0.7175	1.41319	-0.508	0.6123	-3.507	2.072
*$SS_{contrast}/SS_{effect}$	0.01 (1%)					
CONTRAST 6 (F vs. I, e.g. 0;0;0;0;0;1;0;0;-1)	-1.0950	1.41319	-0.775	0.4395	-3.884	1.694
*$SS_{contrast}/SS_{effect}$	0.02 (2%)					
CONTRAST 7 (D vs. I, e.g. 0;0;0;0;0;0;1;0;-1)	-0.5370	1.41319	-0.380	0.7044	-3.326	2.252
*$SS_{contrast}/SS_{effect}$	0.00 (0%)					
CONTRAST 8 (D vs. I, e.g. 0;0;0;0;0;0;0;1;-1)	1.4400	1.41319	1.019	0.3096	-1.349	4.229
*$SS_{contrast}/SS_{effect}$	0.03 (4%)					

Source: own study based on the data studied

The analysis of contrasts carried out between classes where the mean educational value added in natural sciences differed significantly shows that changing school size from Class A (up to 20 graduates) to Class I (161-180 graduates) explains – as was the case with the mean educational value added in mathematics – 52% of differences in the mean educational value added. In addition, there were statistically insignificant but quite significant differences in the mean educational value added between Classes B and I – 21%, as well as between Classes C and I – 17% (table 6). Indicator ω for contrasts was 0.10, meaning that the classes of schools determined by the number of graduates explain only 10% of differences in the mean educational value added between the classes.

Table 6. Evaluation of contrasts for the variable: educational value added in natural sciences

	EVA in natural sciences					
	Scores	SE	T	p	CL -95.00%	CL +95.00%
CONTRAST 1 (A vs. I, e.g. 1;0;0;0;0;0;0;0;-1)	**-4.5425**	**1.36858**	**-3.319**	**0.0011**	**-7.244**	**-1.841**
***$SS_{contrast}/SS_{effect}$**	**0.40 (52%)**					
CONTRAST 2 (B vs. I, e.g. 0;1;0;0;0;0;0;0;-1)	-2.8480	1.36858	-2.081	0.0389	-5.549	-0.147
***$SS_{contrast}/SS_{effect}$**	0.16 (21%)					
CONTRAST 3 (C vs. I, e.g. 0;0;1;0;0;0;0;0;-1)	-2.6375	1.36858	-1.927	0.0556	-5.339	0.064
***$SS_{contrast}/SS_{effect}$**	0.13 (17%)					
CONTRAST 4 (D vs. I, e.g. 0;0;0;1;0;0;0;0;-1)	-0.8180	1.36858	-0.598	0.5508	-3.519	1.883
***$SS_{contrast}/SS_{effect}$**	0.01 (1%)					
CONTRAST 5 (E vs. I, e.g. 0;0;0;0;1;0;0;0;-1)	-0.5180	1.36858	-0.378	0.7055	-3.219	2.183
***$SS_{contrast}/SS_{effect}$**	0.01 (1%)					
CONTRAST 6 (F vs. I, e.g. 0;0;0;0;0;1;0;0;-1)	-0.9885	1.36858	-0.722	0.4711	-3.689	1.712

*$SS_{contrast}/SS_{effect}$	0.02 (3%)					
CONTRAST 7 (D vs. I, e.g. 0;0;0;0;0;0;1;0;-1)	-0.3580	1.36858	-0.262	0.7939	-3.059	2.343
*$SS_{contrast}/SS_{effect}$	0.00 (0%)					
CONTRAST 8 (D vs. I, e.g. 0;0;0;0;0;0;0;1;-1)	1.4625	1.36858	1.069	0.2867	-1.239	4.164
*$SS_{contrast}/SS_{effect}$	0.04 (5%)					

Source: own study based on the data studied

6. Conclusions

The study shows that the mean educational value added is higher in the largest technical schools ranging from 564 to 640 students. This finding is contrary to the opinion that better outcomes are obtained in schools with fewer students. This situation may result from the greater specialization of teachers in large schools; in these schools one teacher teaches only one subject and so he or she has more favourable conditions to achieve a higher level of professional mastery.

Small schools nowadays may face enrolment difficulties resulting in small school branches. In such schools young people show less motivation to learn. Assuming that students with low intellectual abilities go to schools facing enrolment difficulties, it is unfair to evaluate such schools on the basis of 'raw' exam results. Using the educational value-added measure should contribute to a better assessment of such schools, because this measure eliminates the problem of differences in the intellectual levels of students. However, as it has been already mentioned, students' motivation for learning remains a factor that is difficult to measure.

There is also the problem of inequality in the education market, which, exacerbated by a diverse quality of schools, is expressed in increased social segregation and growing educational inequalities (Dolata 2008, p. 253). This study indicates that educational inequalities in schools with fewer students are deepening, but this thesis still needs to be confirmed by further research.

The above investigation – although still requiring extended research – indicates that the existence of large schools is justified. In addition to the quality of teaching, the arguments for increasing the number of students in schools –

especially in technical schools – are the high cost of maintaining small schools and the low efficiency of expensive specialized classrooms.

Summary

Maximizing the quality of education by measuring the educational added value in secondary school technical type on the basis of exam results

The rationale for this study is the search for ways to optimize expenditures on secondary vocational education. Optimization activities should lead to the creation of high quality human capital in the society.

The purpose of this study is to verify the view indicating that schools with fewer students achieve higher learning outcomes.

Nine classes were selected from a group of all secondary technical schools in Poland (N = 1683). Each class consisted of twenty schools selected by the average annual number of graduates in 2013-2015. A univariate analysis ANOVA was then carried out. The dependent variables were educational added values for matriculation exams in Polish language, the humanities, mathematics and natural sciences. The quality predictor in this study was classes determined by the average number of graduates.

The study has led to the conclusion that higher learning outcomes expressed by the average educational added value are achieved in schools with more students. The highest average learning outcomes were achieved in schools with the number of students ranging from 564 to 640. It has also been shown that the average educational added value increases with the number of students in school. It may be supposed that certain numbers of students in school should not be exceeded; however, due to the lack of schools with the number of students far exceeding those in schools covered in this study, it was not possible to determine the maximum number of students in secondary technical schools that would allow them to obtain the expected learning outcomes.

Keywords: *the number of students in schools, educational added value, ANOVA, the optimal number of students in school.*

Streszczenie

Maksymalizacja jakości kształcenia poprzez pomiar edukacyjnej wartości dodanej w szkole ponadgimnazjalnej typu technikum na podstawie wyników egzaminacyjnych

Uzasadnieniem dla podjętego tematu badań jest poszukiwanie dróg optymalizacji nakładów na średnie szkolnictwo zawodowe. Kierunki działań optymalizacyjnych powinny prowadzić do kreowania wysokiej jakości kapitału ludzkiego społeczeństwa.

Jako cel analiz przyjęto zweryfikowanie poglądu wskazującego, że w szkołach liczebnie mniejszych osiąga się wyższe wyniki nauczania. Ze zbioru wszystkich techników w Polsce (N=1683) wytypowano 9 klas. Każda klasa składała się z 20 szkół wytypowanych według średniej rocznej liczby absolwentów w latach 2013-2015. Następnie przeprowadzono jednoczynnikową analizę ANOVA przyjmując jako zmienne zależne wartości edukacyjnej wartości dodanej dla egzaminów maturalnych z języka polskiego, grupy przedmiotów humanistycznych, matematyki oraz grupy przedmiotów matematyczno-przyrodniczych. Predykatorem jakościowym w omawianej analizie były klasy wyznaczone według średniej ilości absolwentów.

Przeprowadzone badania doprowadziły do konkluzji, że wyższe wyniki nauczania wyrażane średnią edukacyjną wartością dodaną uzyskuje się w szkołach liczebnie większych. Najwyższe średnie wyniki nauczania osiągnięto w szkołach o liczebności uczniów z przedziału od 644 do 720. Można nawet zauważyć pewną tendencję, potwierdzaną średnimi wynikami edukacyjnej wartości dodanej, wskazującą, że badana wielkość wzrasta wraz ze wzrostem liczebności szkoły. Przypuszczać należy, że wzrost liczebności szkół posiada pewną wartość maksimum, jednak ze względu na brak szkół o liczebności uczniów znacznie przekraczających rozmiary analizowanych szkół, nie pozwolił na wyznaczenie granicy wskazującej na maksymalny rozmiar szkoły typu technikum, pozwalającej na uzyskiwanie oczekiwanych efektów kształcenia.

Słowa kluczowe: *liczebność szkół, edukacyjna wartość dodana, ANOVA, optymalna wielkość szkoły.*

JEL Codes: A20, A21, A29.

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