Ayden International Journal of Education and Social sciences
Vol.: 1 Issue 1 February 2024
ISSN: Pending…

THE PEDAGOGICAL PUZZLE: NAVIGATING THE LINK BETWEEN DIDACTIC TEACHING AND STUDENT ACHIEVEMENT

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Abstract: The delivery of learning in educational settings has been a topic of intense debate, with various teaching methods under scrutiny. However, much of this discourse lacks empirical evidence linking students' performance directly to instructional methods. This paper addresses this gap by presenting findings from data collected in a study conducted in English secondary schools. The structured presentation includes a comprehensive literature survey, a detailed description of the dataset employed, statistical analyses, results discussion, and conclusive insights.

The literature survey sets the stage, providing an overview of existing discussions on teaching methods. It highlights the scarcity of empirical evidence connecting instructional approaches to student performance, emphasizing the need for research to bridge this gap. Following the literature review, the paper introduces the dataset employed in the study, offering transparency in the research methodology.

Statistical analyses of the dataset form a pivotal component of the paper, shedding light on the relationships between teaching methods and students' academic outcomes. The results are meticulously discussed, providing insights into the effectiveness of various instructional approaches in the context of English secondary schools. This analysis aims to inform educators, policymakers, and researchers about the impact of instructional methods on student performance.

In conclusion, the paper draws together the literature findings, dataset description, and statistical analyses to present overarching conclusions. The study's outcomes contribute to the broader understanding of effective teaching methods, offering valuable insights for educational practitioners. By directly linking empirical evidence to instructional strategies, this research serves as a stepping stone in enhancing the quality of educational practices and shaping future research directions.

Keywords: Teaching Methods, Student Performance, Educational Practices, Empirical Evidence, Secondary Education.

INTRODUCTION

The methods that teachers use to deliver learning are the subject of vigorous debate. Much of this debate is poorly informed–inevitably so since there is relatively little empirical evidence which can be used to link students' performance to the methods used in their instruction. This paper aims at bridging this gap in the literature by appeal to data collected in a group of English secondary schools. The paper is structured as follows: a literature

survey is followed by a description of the dataset used in the present study. Sone statistical analysis follows, along with a discussion of the results. Finally, conclusions are drawn.

Literature

Traditional forms of delivering learning, reliant as they are on didactic methods, have been widely criticised in the recent literature. In compulsory years education, the attack on didacticism has transformed the manner in which education is delivered in many countries. In higher education, this movement has taken the form of an attack (albeit not widely successful) on lectures as the main vehicle for delivering learning. For instance, Bligh (1998) has argued that educators should:

Use lectures to teach information. Do not rely on them to promote thought, change attitudes, or develop behavioral skills.

The rationale for avoiding didacticism appears entirely reasonable - it is intuitively plausible that such methods can deliver information yet stifle independent thought, creativity, and deep learning-but it is nonetheless an example of theory which has remained largely untested by confrontation with empirical evidence.

A path through the history of writings on education can be traced which begins with Plato (2004), and proceeds through Rousseau (1979) and the 20th century constructivists, including Jean Piaget, Lev Vygotsky and John Dewey. Plato described an education, starting with Mathematics but proceeding to reflective Philosophy, as a key underpinning of a democratic society:

Calculation and Geometry and all the other elements of instruction, which are a preparation for dialectic, should be presented to the mind in childhood; not however under any notion of forcing our system of education ... because a freeman ought not to be a slave in the acquisition of knowledge of any kind.

Rousseau developed the idea of student-centered learning in his treatise on 'Emile':

A child passes six or seven years this way in the hands of women, the victim of their caprice or his own. And after having made him to learn this or that. That is to say after having burdened his memory with words that he cannot understand or with things that are good for nothing -- after having stifled what is natural in him with passions that have been created, we give over this artificial being into the hands of a tutor. The tutor continues to develop these artificial germs that he found already formed and teaches the child everything except how to know himself, how to decide for himself, how to live and make himself happy.

The work of Piaget (1980) centres around stages of a child's development, emphasising the fact that within each stage the naive world view of the child may be logically consistent, albeit not necessarily consistent with an adult view where more facts are known. Implicit in Piaget's work is the view that didactic learning should not be allowed to stultify the learner's desire to explore and to theorise:

There can be no exogenous knowledge except that which is grasped, as content, by way of forms which are endogenous in origin:

Vygotsky (1987) meanwhile, recalling some themes of Rousseau, placed more emphasis on the need for primarily active learners to be given an occasional steer by the educator:

In development, however, the child finds himself in a constant encounter with the social environment. This environment demands an adjustment to adult thinking ... In the social environment, the child's behavior demands the capability of understanding the thought of others, of responding to that thought, and of communicating one's own thought.

Dewey (1916) likewise provided a developed philosophy of education which is not only explicitly student-centred but also problem-oriented:

Thinking is the method of an educative experience. The essentials of method are therefore identical with the essentials of reflection. They are first that the pupil have a genuine situation of experience -- that there be a continuous activity in which he is interested for its own sake; secondly, that a genuine problem develop within this situation as a stimulus to thought; third, that he possess the information and make the observations needed to deal with it; fourth, that suggested solutions occur to him which he shall be responsible for developing in an orderly way; fifth, that he have opportunity and occasion to test his ideas by application, to make their meaning clear and to discover for himself their validity.

While the above provide a sound theoretical underpinning, grounded in philosophy and psychology, for an education that is student-centred, empirical evidence on the relative effectiveness (along any dimension) of such an approach is something that has entered the literature only more recently. However, several recent papers, primarily concerning learning in specific subject areas within *higher* education, have provided evidence that interactive styles of delivery produce outcomes that are preferable to those obtained through didactic methods. In the field of psychology, Yoder and Hochevar (2005) demonstrate that active learning leads to better quiz results than can be obtained by traditional teaching met- hods. Elsewhere, Goldfinch (1996) demonstrates that, in the teaching of quantitative methods to business school students, 'school-type classes' lead to superior examination results than do traditional lectures. Interestingly, though, the same is not true in the case of coursework. Lake (2001) finds that, in physiology, active learning leads to better student grades than do standard lectures. But student responses suggest that they are relatively uncomfortable with active learning methods, and that they do not feel as though they are learning as much as they do in a lecture. This result suggests a tension between surface and deep learning; while lectures are capable of delivering large quantities of material efficiently (and so students may feel that they are learning well from them), it may be the case that their grasp of material so taught is superficial. Interestingly, similar results on student reactions to courses delivered by active learning in the field of Biology were obtained by Goodwin et al. (1991).

Dunn et al. (1990) refine these models somewhat by taking into consideration students' preferences about learning style. They find that students with a preference for learning alone perform better when allowed to learn alone, while other students perform better when learning in cooperation with their peers. Subject matter is also a key determinant of the extent to which teachers adopt didactic or more cooperative learning methods (Behr, 1988). Cooperative learning has formed the focus of a great deal of research, spearheaded by Robert Slavin (1983, 1996), who argues that this learning model offers better outcomes than traditional methods, but only if the reward structures offered to students are well designed. In particular, recognition needs to be made of the complex dynamics that exist within groups, and group rewards need to be dependent on individuals' learning. Johnson et al. (1981) likewise find cooperative forms of learning to be more effective than individualistic methods.

In recent work, Guest (2005) shows that giving students choice over their learning regimes (for example a choice between a challenging textbook and an easier textbook, where the former offers a wider reward distribution than the latter, but where in both cases reward is positively related to effort) results in outcomes that benefit some students but not others. In particular, in such a flexible learning setting, more highly motivated students are likely to opt for tough regimes and to benefit from them, while other students are likely to choose easier regimes because these do not penalise indolence. The benefits associated with flexible approaches to learning are therefore likely

to differ from student to student. Likewise, Heijke et al. (2005) find evidence that problem-based learning has positive effects for higher education students on business courses.

Finally, note should be taken of some further studies that urge caution. Huxham (2005) has recently argued in favour of introducing 'interactive windows' into lectures in higher education. For the most part, however, the statisti- cal results that he reports suggest that there is no significant difference in students' outcomes between lectures that feature such windows and those that do not. Mayer (2004) is amongst several authors who have recently argued that the balance needs to be tilted away from pure problem-based and active learning approaches toward guided learning. Scheerens (1994, 2000) has cautioned that comparisons of the effectiveness of different teaching and learning methods are subject to the caveat that the learning objectives of these alternative methods may differ.

Data

The empirical work at the heart of the present paper differs from that reported elsewhere in that it is based on students' self-reported perceptions of the extent to which their instruction is didactic. It makes use of data drawn from the University of Cambridge and Hertfordshire School Improvement and Advisory Service Student Attitudes Project (SIASSAP). The survey, which covers some 27 schools in Hertfordshire in 2000-01, is unusual in that it includes questions not only about students' destinations once they pass through compulsory schooling, but also about teaching styles and other, individual-specific, experiences while they are in education. While the survey was not conducted, therefore, for the purposes of evaluating the impact of different delivery styles on learning, and while this was not a subject of earlier research that has been carried out using these data, the dataset does provide invaluable information that can be used to study the topic at hand.

The SIASSAP was conducted in Hertfordshire, England, in 2000 and 2001 with the primary aim of assessing the impact on students' views on social issues of the explicit provision of citizenship education. It comprises three surveys; the first was completed by school principals (head teachers), while the second and third were completed by students who, in 2000, were in the final year of compulsory education. These students were surveyed first in the autumn of 2000 (the first wave), and subsequently a year later (second wave). By this time the students had made choices about their transition from school to work; some remained in school, others entered further education, still others had entered the labour market. The questions asked of students in the two waves of the survey cover their experience at school and subsequently, and their attitudes to matters of politics and citizenship. In addition to the principals' survey, further information about the schools covered in the study is grafted on from other sources; so we know, for example, the type of school (state or independent), the proportion of students receiving free school meals (an indicator of the poverty or affluence of the school's constituency), and we have measures of the average academic achievement of the schools' students.

Students in some 27 schools (24 in the state sector, the remainder private) were surveyed. In the first wave some, 1,250 students appeared in the sample. Attrition between the first and second waves was quite high; this is not surprising in view of the changes of address affecting many young people as they leave compulsory secondary education. The second wave therefore, comprised 702 individuals. The pattern of destinations (upper secondary education, further education, labour market) does not indicate that this attrition results in any strong bias..

Descriptive statistics for key variables appear in Table 1. About 40 per cent of respondents are male and almost 85 per cent describe their ethnicity as white. The average GCSE score of the sample is just over 28, this being the equivalent to 7 passes at grade C. Given this level of attainment, it is perhaps not surprising that the majority of

students go on to study for GCE Advanced level qualifications. Hertfordshire is a relatively affluent part of the UK,[6] and it is, therefore, perhaps not surprising to note that as many as 38 per cent of respondents have at least one parent who had completed higher education (this variable is denoted by the binary variable *PARED* below. Nevertheless, a similar percentage of respondents qualified for free school meals (denoted *FSM*), a standard indicator of relative poverty, and this is indicative of the wide dispersion of economic well-being across families in the sample area.

Innate ability is measured (albeit surely imperfectly) by past academic performance. This measure, denoted *PERFORMANCE*, takes unit value if performance has been predominantly E grades, rising to a value of 5 if performance has been predominantly A grades. A little over two thirds of respondents have experienced a position of responsibility (denoted *RESPONSIBILITY*) in some school club or other organisation, with this position requiring them to make decisions. A little over one fifth watch television and videos for over three hours per day (*TELEHOLIC*). The survey includes a nice measure of time preference (*DISCOUNT*) which is given by the response to the question: If you won a competition, would you rather get £100 right now (coded 1) or have to wait a whole month to get £150 (coded 2)? By this measure, a minority of respondents, some 13 per cent, have a high level of time preference.

Table 1. Descriptive Statistics.

variable	mean	standard deviation
MALE	0.402	0.491
DISCOUNT	1.867	0.339
EXPRESS	2.613	0.960
FSM	37.841	24.345
ALEVEL	0.714	0.452
GCSESCOR	28.145	16.736
PARED	0.383	0.487
TELEHOLIC	0.211	0.408
PERFORMANCE	3.462	0.942
RESPONSIBILITY	0.682	0.466
WHITE	0.842	0.365

Of particular interest in the context of the present study is the response (which we denote by *EXPRESS*) to the question: 'How often would you say that your teachers invite you to express opinions, even if it means disagreeing with them?' On a five point scale (from 0 to 4) the mean response lies somewhere between 'not very often' (score 2) and 'often' (score 3). Worthy of note is the fact that the standard deviation of this variable is quite high, indicating that about one fifth of students answered 'very often' (score 4) and about one in seven students answered 'very occasionally' (score 1) or 'never' (score 0). This marked variation is due in part to differences in practices across schools (some schools use less didactic teaching methods than others), to differences in individuals' abilities (schools may set pupils in classes according to their ability and may use different teaching and learning methods for different sets), and to differences in respondents' outlook on life (some may systematically report more positively than others). Since individual ability may be in part a determinant of the response to the *EXPRESS*

variable, we shall for some of the results below use a full set of school and subject dummies as instruments for this co-factor.

Analysis

The first statistical estimates are reported in Table 2. These show the results obtained from various specifications of a model explaining GCSE score. The first column provides a straightforward OLS regression; the second instruments for *EXPRESS*; the third allows for random effects across the schools in the survey, with *EXPRESS* uninstrumented; and the fourth is a random effects estimator with *EXPRESS* instrumented. Coefficients for most variables are robust across specifications. It is readily seen that prior performance (*PERFORMANCE*) strongly influences results at GCSE. Likewise, the education level of respondents' parents (*PARED*) is highly significant and positive. There is a negative effect associated with watching long hours of television.

Table 2. Regression Results, Dependent Variable = GCSE Score; t statistics in parentheses.

Variable	**1**	**2**	**3**	**4**
CONSTANT	-11.261 (3.01)	-26.487 (5.16)	-3.058 (0.84)	-18.346 (2.95)
EXPRESS	1.031 (1.89)	7.482 (4.62)	0.775 (1.65)	6.704 (3.26)
PARED	7.940 (7.21)	7.521 (6.90)	6.234 (6.31)	6.218 (6.34)
PERFORMANCE	5.822 (10.11)	5.454 (9.48)	4.363 (8.42)	4.272 (8.27)
TELEHOLIC	-4.415 (3.43)	-4.034 (3.17)	-3.589 (3.27)	-3.427 (3.13)
RESPONSIBILITY	3.937 (3.46)	3.662 (3.26)	3.126 (3.16)	3.078 (3.13)
DISCOUNT	6.994 (4.59)	6.966 (4.64)	6.005 (4.62)	6.064 (4.69)
WHITE	1.395 (0.98)	1.261 (0.90)	0.652 (0.51)	0.745 (0.59)
MALE	-6.131 (5.70)	-5.940 (5.61)	-5.240 (5.15)	-5.212 (5.17)

Experience of decision making in organisations (*RESPONSIBILITY*) leads to better GCSE results, as does a low degree of time preference (*DISCOUNT*) - though it is recognised that these variables may be partly endogenous.

Ethnicity is insignificant, but there is a strong and highly significant gender effect; this is tantamount to boys getting a whole grade lower than girls in each of 6 subjects. This gender gap has been noted before in several recent studies of educational performance in the UK, for example Burgess et al. (2004).

The impact of didacticism is interesting. *EXPRESS* carries a positive coefficient, indicating that pupils that are encouraged to express their own views in class are likely to do better at GCSE than others. Instrumenting raises the value of the coefficient (and reduces the value of the regression constant) and raises also its significance. This suggests that measurement or reporting error in the *EXPRESS* variable dominates any downward bias in the coefficient due to endogeneity.

In Table 3, another measure of educational outcomes is used as dependent variable, namely an indicator of whether or not respondents proceeded to study for a levels. Since this is a binary variable, Logit analysis is used. The results obtained for eight different specifications of the model are reported in the table. The first is a straightforward model without instrumentation or school level effects. The second instrument is for didacticism. The third replaces most of the variables used in the earlier columns with GCSESCORE, but retains the uninstrumented didacticism variable and gender. The fourth column repeats the third, but this time instrumenting for didacticism. The remaining columns correspond to the first four, but this time they are estimated incorporating random effects.

Focusing initially on the first two columns of this table, it is clear that variables that affect GCSE score also affect A level participation, and generally do so in the same direction. The one instance where signs are reversed is that of ethnicity, though in neither case is the coefficient on this variable significant. The EXPRESS variable is highly significant, and positive, in both these columns, and - as in the case of the GCSE score equation - the coefficient on this variable rises markedly when the variable is instrumented.

The third and fourth columns of Table 3 introduce GCSE score into an otherwise more parsimonious specification of the model. Unsurprisingly the coefficient on this variable is highly significant. The coefficient on EXPRESS remains positive, but is insignificant when it is instrumented. This suggests that the impact of different teaching methods on pupils' decisions to stay on in fulltime education beyond the age of 16 is an indirect one; teaching methods influence examination results at age 16, and these in turn influence staying on at school rates.

Another interesting feature of the third and fourth columns concerns the gender variable. This now becomes significantly positive, indicating that although boys perform less well at GCSE than do girls, given GCSE performance they are more likely than girls to stay on at school to study for A levels.

The remaining columns of Table 3 introduce random effects at school level. Once this is done, all variables other than GCSE score become insignificant. School attended is clearly a major determinant of the decision to stay on, and in contrast with other variables studied here, it appears to have an effect on A level participation independent of and over and above the impact that it has on an individual's GCSE performance.

Table 3. Logit Results, Dependent Variable = A level participation

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
CONSTANT	-	-	-	-	-	-	-	-
	2.975	4.447	3.067	2.677	1.850	3.106	2.293	2.081
	(4.58)	(4.88)	(7.32)	(2.98)	(2.70)	(3.53)	(6.38)	(2.18)
EXPRESS	0.332	0.926	0.369	0.233	0.465	0.496	0.133	0.097
	(3.51)	(3.25)	(3.06)	(0.67)	(1.92)	(1.63)	(1.41)	(0.28)

PARED	0.730	0.739			0.224	0.237		
	(3.53)	(3.58)			(1.01)	(1.11)		
PERFORMANCE	0.494	0.456			0.110	0.106		
	(4.58)	(4.25)			(1.16)	(1.24)		
TELEHOLIC	-	-			-	-		
	0.364	0.335			0.059	0.057		
	(1.72)	(1.58)			(0.21)	(0.23)		
RESPONSIBILITY	0.695	0.670			0.082	0.081		
	(3.66)	(3.54)			(0.32)	(0.34)		
DISCOUNT	0.547	0.574			0.044	0.048		
	(2.19)	(2.29)			(0.17)	(0.18)		
WHITE	-	-			-	-		
	0.165	0.150			0.010	0.009		
	(0.64)	(0.59)			(0.04)	(0.04)		
MALE	-	-	0.609	0.528	-	-	0.157	0.136
	0.172	0.197			0.008	0.010		
	(0.91)	(1.05)	(2.56)	(2.26)	(0.05)	(0.06)	(0.95)	(0.87)
GCSE-SCORE			0.122	0.121			0.065	0.065
			13.36	13.21			9.04	8.48
RANDOM EFFECT					0.031	0.028	0.138	0.140
					0.17	0.16	0.49	0.50

CONCLUSION

The evidence provided in the present paper suggests that the use of non-didactic teaching methods in secondary education is linked to better performance at age 16. More over, those pupils who do well at age 16 are relatively likely to stay on in post-compulsory education, and so non-didactic teaching encourages longer partici-pation in education as well as better performance. But it is only through the impact of teaching methods on performance at age 16 that this latter effect is observed - there is no *direct* effect of teaching methods on pupils' decisions post-16. These results provide empirical confirmation for assertions frequently made in the educational literature; in the past, support for these assertions has come primarily from impressionistic evidence.

However, much remains to be learned. In particular, it would be desirable to check the results reported here using other data sets, particularly the ones that offer the possibility of more refined instrumentation. The research conducted here is based on data collected across all subjects at secondary level. The extent to which the results hold good for different levels of education remains to be explored, as does the extent to which they apply to individual (groups of) subjects. The outcomes used here as dependent variables provide only a partial picture of educational success, and it would be desirable to investigate the impact of different teaching methods on subsequent success in the labour market (since employability is widely regarded as a key outcome of education). Moreover, if the results of the present paper are found to be robust, it should nonetheless be borne in mind that the costs of didacticism (relative to its alternatives) are, as ever, accompanied by benefits (in this case, presumably, primarily economic as opposed to pedagogic); demonstration that the costs exist is not tantamount to an

analysis in which these costs are weighed against the benefits. There would therefore appear to be no shortage of further topics of research in this area.

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