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Promoting quality and equity in socially disadvantaged schools: A group- randomisation study

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ABSTRACT

This study investigates the impact of the Dynamic Approach to School Improvement (DASI) on promoting *quality* and *equity*. Forty primary schools in socially disadvantaged areas were randomly split into two groups. The control group was supported to develop action plans, whereas the experimental group used DASI. To investigate the impact of DASI on quality, student achievement gains in mathematics were measured. Using multilevel analyses the experimental schools managed to promote student achievement more than schools of the control group. To investigate the impact of DASI on equity, the impact of the socioeconomic status (SES) on student achievement was measured. The effect of SES was reduced only in the experimental schools. Implications for research, policy and practice are drawn.

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1. Introduction

It is expected generally in society that education should achieve high results in different domains of learning and subject areas. This means that the criteria for effectiveness will be at the level to be obtained by individual students, classes, and schools with respect to those objectives (*quality*). However, it is also possible to look at the effectiveness of a school from a different angle, especially through investigating how far schools and teachers managed to reduce the learning differences between students coming from different socioeconomic backgrounds (*equity*). At this point, it should be acknowledged that there are different views of equity which emerge from different philosophical and ideological assumptions about the role of schooling in reducing differences in student learning outcomes with most dominant ones the *meritocratic* and the *egalitarian* views. Those supporting the meritocratic view consider differences in student learning outcomes to differences between students in talents and amount of work dedicated to schooling. However, the meritocratic view is difficult to implement as different hidden mechanisms operate in society which makes it harder for some students to develop their talents than for others, even if students are given access to learning

opportunities (Lim, 2013). On the other hand, the egalitarian view points out that commitment to equity suggests that differences in outcomes of schooling should not be attributable to differences in the socioeconomic background of students. This implies that extra learning opportunities and guidance for socially disadvantaged groups of students are required to assure equal chances for all students. In this paper the different views of equity are not discussed but it is pointed out that one can look at the effectiveness of a school from a different angle, especially through investigating how far schools and teachers managed to reduce the impact of different background factors on student learning outcomes (*equity*). This results in educational objectives and criteria for educational effectiveness which are not related to a specific objective and specific students, but related to different groups of students in relationship to each other. The idea behind this is that education can contribute to social justice and democracy by closing the gap between students with regards to their background, especially their abilities and the socio-cultural status of their family (Lafontaine, Baye, Vieluf, & Monseur, 2015; Sammons, 2010).

However, international evaluation studies reveal that the performance of students from disadvantaged background both within and across countries differs substantially from other students. For example, the latest Programme for International Student Assessment (PISA) study revealed that across the Organisation for Economic Co-operation and Development (OECD) countries approximately 20% of the youth is not equipped with the

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basic skills in mathematics. Disadvantaged students are twice as likely as their advantaged peers to be poor performers, implying that personal or social circumstances may be obstacles to achieving their potentials (Schleicher, 2014). PISA also reports that 40% of the variation in student performance in mathematics is found between schools within a country. This implies that interventions aiming to improve the quality of underperforming schools are needed. Moreover, research shows that interventions supporting primary school students who are at risk have stronger effects than those addressing students at secondary school level (Scheerens & Bosker, 1997; Townsend, 2007). Furthermore, various syntheses of effectiveness programs aiming to improve the attainment of primary students with low basic skills reveal that whole school interventions are more effective (e.g., Borman, Hewes, Overman, & Brown, 2003; Hattie, 2009). In this context, this paper presents the results of a study investigating the extent to which a whole school intervention based on the *Dynamic Approach to School Improvement (DASI)* (Creemers & Kyriakides, 2012) can promote quality and equity in socially disadvantaged schools. Thus, the first part of the paper attempts to illustrate the importance of investigating the school effect on promoting quality and equity. We also refer to the importance of using DASI to undertake interventions at school level in order to promote quality and equity.

2. Measuring quality and equity at school level

Work on equal educational opportunities conducted fifty years ago by Coleman and his colleagues (Coleman et al., 1966) and Jencks and his colleagues (Jencks et al., 1972) argued that student achievement can be predicted mainly by background characteristics of students and especially their Socio-Economic Status (SES) and their intelligence. These studies claimed that after controlling for student background factors, not much variance in student achievement is left for teachers and schools to explain. These findings resulted in a pessimistic view on the contribution that teachers and schools can have in promoting student learning outcomes. In this context, two studies conducted independently in USA (Brookover, Beady, Flood, Schweitzer, & Wisenbaker, 1979) and UK (Rutter, Maughan, Mortimore, Ouston, & Smith, 1979) were concerned with examining evidence demonstrating the impact that teachers and schools can have on promoting student learning outcomes. As a consequence, the early school effectiveness research and school improvement projects had been determined, more or less, by the idea of creating effective schools for the urban poor (Edmonds, 1979). In the 1980s, there was quite a lot of criticism against this kind of school improvement and research with its conspicuous sampling biases (Firestone & Herriott, 1982; Purkey & Smith, 1983; Ralph & Fennessey, 1983; Rowan, Bossart, & Dwyer, 1983). As a result, during the last three decades various large scale effectiveness studies were conducted in several countries demonstrating the impact that teachers and schools can have in promoting student learning outcomes (Muijs et al., 2014; Reynolds et al., 2014). Moreover, accountability systems have been developed in several countries which treat the progress made by students as the main criterion for evaluating teachers and schools (Ray, 2006; Sanders & Horn, 1994). Furthermore, the great majority of effectiveness studies conducted in various countries revealed that after controlling for background factors a lot of variation at the school level remains (Chapman, Muijs, Reynolds, Sammons, & Teddlie, 2016; Townsend, 2007) and the variation that is left unexplained is treated as an indicator of the school effect on student learning outcomes (Goldstein, 2003; Thomas, Peng, & Gray, 2007). As a consequence, there is nowadays substantial agreement as to appropriate methods of estimating school differences or effects and the kinds of data required for valid

comparisons to be made in relation to the promoting of quality (Dumay, Coe, & Anumendem, 2014; Goldstein, 1997).

In regard to the impact of schools on equity, some studies revealed that teachers and schools matter most for underprivileged and/or initially low-achieving students (Scheerens & Bosker, 1997). This implies that schools which are effective in terms of the quality dimension may also be effective in reducing the learning differences between students coming from different socio-economic backgrounds. However, almost all effectiveness studies measure school effectiveness in relation to the quality dimension (Sammons, 2010) and thereby a methodology to measure the impact of schools in promoting equity has not yet been clearly developed (Kelly, 2012). Nevertheless, during the last decade an emphasis on investigating equity has gradually been developed. In his paper, equity is seen as related with fairness which implies that personal or socio-economical characteristics such as gender, ethnic origin or family background should not be obstacles to success in education. In this context, OECD developed a specific indicator to measure equity at country level which is concerned with the impact that the SES has on student achievement. It is argued that equitable educational systems are those where SES has a relatively small effect on student learning outcomes. One could therefore evaluate an intervention aiming to promote equity by investigating the extent to which the effect of SES on achievement has been reduced.

3. Establishing a dynamic approach to school improvement: assumptions and features

Most reform policies either at macro or micro level usually try to change the role of various stakeholders and introduce new ideas/concepts and/or theoretical notions and/or a specific theory. For example, the introduction of a new curricula or textbook aims to raise the awareness of teachers about the importance of achieving specific aims and/or using specific teaching approaches such as the use of new learning approaches and/or differentiation of teaching. Also school improvement projects that invite students, parents and teachers to design their own improvement plans are based on the assumption that ownership will result in improving more or less specified or even unspecified change (e.g., the climate of the school). However, a meta-evaluation of school improvement studies revealed that some of these projects failed to improve the quality of education due to the fact that they were based on theories which were not tested in a systematic way (see Creemers & Kyriakides, 2012). Thus, DASI promotes the design of school improvement projects that are based on a theory which has been tested. Specifically, the proposed approach to school improvement has its own theoretical framework which refers to factors of educational effectiveness that need to be considered in introducing a change at school level. By making use of the dynamic model of educational effectiveness (Creemers & Kyriakides, 2008), this approach draws attention to the importance of improving school policy for teaching and the school learning environment since these two overarching factors were found to be associated with student achievement gains (Kyriakides, Creemers, Antoniou, & Demetriou, 2010; Hattie, 2009; Scheerens, Seidel, Witziers, Hendriks, & Doornekamp, 2005).

Second, DASI is based on the assumption that student learning should be considered as the ultimate aim of any school improvement effort. Unless learning and learning outcomes are improved, any school improvement effort should not be considered successful no matter how much it may manage to improve any aspect of the climate of the school or any other school factor which is not related with student learning. This is due to the fact that learning is the mission of the school and emphasis should be placed on improving learning outcomes. This assumption implies

that at the very early stage of any school improvement project, clarity about the purpose of improvement should be established and school stakeholders should commit themselves to the improvement of student learning outcomes.

Third, DASI refers to school factors found to be associated with learning outcomes. It is expected that schools should establish clarity not only about the general aim of the improvement project but also about its intermediate objectives which should be concerned with the improvement of the functioning of school factors that are associated with student learning outcomes (cognitive and affective). Since DASI is based on the dynamic model which refers to school factors that are changeable and associated with student learning outcomes (Creemers & Kyriakides, 2010b; Kyriakides, Creemers, Antoniou, Demetriou, & Charalambous, 2015), the intermediate objectives should also address the needs of schools to improve the functioning of the school policy for teaching and/or the policy for improving the school learning environment.

Fourth, DASI is based on the assumption that each school should develop its own strategies and action plans for improvement, but support to schools should be offered by an Advisory and Research Team (A&RTeam), which is able to provide technical expertise and the available knowledge-base on improvement of factors addressed by the school. Although a school is treated as a professional community responsible for designing and implementing its own improvement strategies and action plans, school stakeholders are not left alone to design and implement their strategies and actions, but are encouraged to make use of the A&RTeam and any other available resource within and/or outside of the school. Therefore, a systematic research based approach to design, implement, and evaluate improvement efforts (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010; Rowan, Correnti, Miller, & Camburn, 2009), is promoted by DASI.

Fifth, DASI is based on the assumptions that both the A&RTeam and the school stakeholders should be involved in the design and the evaluation of the improvement project. In this way, we avoid the problems that may arise in conducting experimental studies where practitioners see themselves as those who are expected to follow in a rather strict way an intervention which was designed by others and thereby ownership is not established. Moreover, interventions found to have an impact when they are implemented under the supervision of a research team who follows a strict experimental approach may have no effect when practitioners are left alone to implement them. It is partly for this reason that problems with the external validity of some experimental studies are reported in the literature (Cronbach, 1990; Shadish, Cook, & Campbell, 2002). In the case of DASI, school stakeholders are those who take decisions on which improvement actions and tasks should be carried out. By using this approach, not only ownership of the improvement project is likely to be established but also the stakeholders' experiences and the special situation of the school are taken into account. At the same time, the A&RTeam has an important role to play since it is expected to share its expertise and knowledge with practitioners and help them develop strategies and action plans that are in line with the relevant knowledge-base of Educational Effectiveness Research (EER). This element of DASI reveals its main difference from school improvement approaches that give emphasis only to the professional experience of school stakeholders and not to the available knowledge-base emerged from educational effectiveness studies (see Creemers & Kyriakides, 2012).

Finally, DASI is concerned with the impact of the improvement project on student learning outcomes and thereby a summative evaluation is undertaken searching for the impact of the intervention on student learning outcomes. This implies that DASI promotes a special approach to improvement where stakeholders

and the A&RTeam have to collaborate in order to develop improvement strategies and action plans, implement them and evaluate their impact on student learning outcomes but each party has a specific role and expertise that brings to the improvement intervention so they are not expected to play the same role in the school improvement process.

Fig. 1 illustrates the major steps of DASI. It is shown that school stakeholders and the A&RTeam are expected to be actively involved in each step of DASI. Their ability to work together and exchange skills, expertise and experience is critical to the success of the school improvement project. The first two steps are concerned with the establishment of clarity and consensus about the aims of the school improvement project. Initially, the importance of promoting student learning is stressed (step A). This implies that school stakeholders and the A&RTeam should define the aims of their intervention by taking into account the fact that promotion of student learning must be the ultimate aim of any school improvement effort. In the case of the study reported here the importance of promoting both quality and equity was stressed at this stage of the intervention. In the second step, the dynamic model and its factors are presented to the school stakeholders. This presentation may help school stakeholders understand how and why addressing the school factors may promote student learning outcomes. In the third step, school stakeholders (with the support

Fig. 1. The major steps of the Dynamic Approach to School Improvement (DASI).

of the A&RTeam) should develop their own evaluation mechanisms in order to collect and analyse data about the functioning of school factors and identify their priority area(s) for improvement. The fourth step is one of the most important steps of DASI. The A&RTeam should work closely with the school stakeholders in order to help them define their own improvement strategies and action plans. School stakeholders are expected to take into account the available knowledge-base of EER. A handbook indicating actions that could be taken to improve the functioning of each school factor in relation to their improvement priorities is provided by the A&RTeam. School stakeholders are expected to adopt these guidelines to their school context (with the help of the A&RTeam). Then, school stakeholders and the A&RTeam should develop mechanisms for monitoring the implementation of the intervention (see step E). At this point, the role of formative evaluation is stressed and the importance of using evaluation data to further develop the school improvement strategies and action plans is emphasised. Finally, the A&RTeam and the school stakeholders should measure the impact of DASI on promoting student learning outcomes and reducing the learning differences between students coming from different socioeconomic backgrounds (step F). This step may also reveal a new priority area for improvement. In particular, if evaluation reveals that a school has managed substantially to improve the functioning of the factor(s) addressed during the implementation of the project, school stakeholders and the A&RTeam may decide to collect evaluation data and identify a new priority improvement area. By collecting data on the functioning of school factors (i.e., moving back to step C) the new priority area may be identified and a new improvement project may be developed and implemented. It can therefore be claimed that Fig. 1 shows that improving school effectiveness is an ongoing and never-ending process, irrespective of how effective a school might be, something that demonstrates that DASI takes into account the dynamic nature of educational effectiveness. Improvement efforts are continuous, cyclical in nature, and embedded in a wider process of overall school development. In the next section, we advocate the use of DASI to promote not only quality but also equity.

4. Using the dynamic approach to school improvement to promote quality and equity

This section advocates for the use of DASI to promote quality and equity in education. In regard to its impact on quality, it is stressed that four experimental studies revealed that DASI had a stronger impact on improving learning outcomes than the participatory approach to teacher and school improvement which gives emphasis to professional experience. The first two studies were concerned with interventions addressing the quality of teaching (Antoniou & Kyriakides, 2011; Christoforidou, Kyriakides, Antoniou, & Creemers, 2014) and revealed that the use of DASI had a statistically significant impact on improving the teaching and assessment skills of teachers and through that the learning outcomes of their students. The other two studies were concerned with interventions addressing school factors. Specifically, the third study was concerned with the attempt of schools to establish self-evaluation mechanisms for improvement purposes (Demetriou & Kyriakides, 2012). DASI was found to have stronger impact on student achievement gains in mathematics than the participatory approach. The fourth study took place in five European countries (i.e. Belgium, Cyprus, England, Greece, and the Netherlands) and was concerned with the use of DASI for reducing bullying (Kyriakides et al., 2013). Schools which made use of DASI were able to reduce bullying at a significantly higher level than the schools of the control group. Although these four studies provide some empirical support on the impact that DASI can have on promoting

student learning outcomes (quality), participating schools were not situated in socially disadvantaged areas. Thus, the study reported here moves a step forward and investigates the impact of DASI on promoting quality in socially disadvantaged schools. Given that early effectiveness studies were concerned with identifying ways to help schools in disadvantaged areas to achieve learning outcomes, it is important to find out whether DASI can help schools in low disadvantaged areas to become more effective.

In regard to the impact that DASI may have on promoting equity, it is taken into account that the effectiveness factors situated at the school level of the dynamic model are considered to be multidimensional constructs. Specifically, the dynamic model incorporates a specific framework for measuring the functioning of factors which comprises five measurement dimensions: *frequency*, *focus*, *stage*, *quality* and *differentiation*. Frequency is a quantitative way to measure the functioning of each effectiveness factor, whereas the other four dimensions examine qualitative characteristics of the functioning of the factors and describe the complex nature of educational effectiveness. In the next paragraphs we explain briefly how each dimension is used to measure the effect of a factor on student achievement.

The *frequency* dimension refers to how often an activity associated with an effectiveness factor is present in a system, school, or classroom and this is probably the easiest way to measure the effect of a factor on student achievement. The factors are also measured by taking into account the *focus* of the activities associated with a factor, which incorporates two aspects. The first aspect of the focus dimension of each factor should address the purpose(s) for which an activity takes place and it is taken into account that an activity may be expected to achieve single or multiple purposes. The second aspect of the focus dimension refers to the specificity of the activities, which can range from specific to general. Also, the activities associated with a factor can be measured by taking into account the *stage* at which they take place. Factors need to take place over a long period of time to ensure that they have a continuous direct or indirect effect on student learning. Moreover, the *quality* dimension refers to the properties of the specific factor itself, as these are discussed in the literature. The importance of using this dimension arises from the fact that looking at the quantity element of a factor ignores the fact that the functioning of the factor may vary.

Finally, *differentiation* refers to the extent to which activities associated with a factor are implemented in the same way for all the subjects involved with it. The importance of treating differentiation as a separate dimension of measuring effectiveness factors arises from the fact that students of any age and in any culture will differ from one another in various intellectual and psychomotor skills, in both generalised and specialised prior knowledge, in interests and motives, in their socioeconomical background, and in personal styles of thoughts and work during learning (Dowson & McInerney, 2003). Thus, adaptation to specific needs of each subject or group of subjects will increase the successful implementation of a factor and will ultimately maximize its effect on student learning outcomes. This implies that beyond differentiation in teaching, we also need to consider the differentiation dimension in defining school factors and especially in taking actions to improve the school learning environment and the school policy for teaching (Creemers & Kyriakides, 2010a). Thus, DASI raises awareness to the importance of promoting differentiation at class and school level and through that learning differences between students coming from different socioeconomic backgrounds may be reduced. For example, there is a debate on the impact that interventions on parental involvement may have on the equity dimension of effectiveness. There are studies which show that improving parental involvement in general may promote learning outcomes but not for students with

less favourable home learning environment and thereby may increase the impact of the SES on student learning outcomes (Feuerstein, 2000; Grolnick, Benjet, Kurowski, & Apostoleris, 1997; Lareau, 1987). On the other hand, there are some other studies which show that projects aiming to improve parental involvement may be more effective for schools in socially disadvantaged areas and may contribute in reducing the impact of SES on student achievement (Christenson, Rounds, & Gorney, 1992; Epstein, 1991; Singh et al., 1995). These contradicting findings could be attributed to the importance of considering differentiation in developing and implementing school policy on partnership (Fan & Chen, 2001; Kyriakides, 2005). Similar contradicting results can be identified on studies investigating the impact of school policy on homework which also reveal the importance of encouraging differentiation at classroom level as well as at the school level and especially in designing the school policy on homework and its relation to partnership policy (Kyriakides et al., 2010; Scheerens et al., 2005). It is finally important to mention that DASI gives emphasis to school evaluation which can generate data that may help schools identify their own improvement priorities by taking into account the extra needs of specific groups of children. Therefore, the study reported here took place in socially disadvantaged schools and attempted to examine the impact that DASI may have not only on student achievement gains in mathematics (quality) but also on reducing the impact that SES can have on student achievement in mathematics (equity).

5. Methods

5.1. Participants

At the beginning of school year 2012–2013, a sample of 40 primary schools of Cyprus in socially disadvantaged areas was selected and randomly split into two groups. No statistically significant difference at 0.05 level between the two groups in relation to the background characteristics of their students (i.e., gender, SES, ethnicity) was identified. A pre-measure of achievement in mathematics of all grade 4, 5 and 6 students ($n=5520$) of the participating schools and of the functioning of school factors was conducted. Then, both groups were asked to develop improvement strategies and action plans to promote quality and equity. The next part of this section provides a brief description of the intervention that took place in these schools in order to promote quality and equity. At the end of the school year, student achievement in mathematics and the functioning of school factors were measured.

5.2. The treatment offered to the experimental group

At the first stage of the intervention, training and provision of guidelines were offered to the participating primary schools ($n=20$). A handbook was also produced which presented the theoretical framework and provided suggestions to schools on how to build school evaluation mechanisms that aim to improve educational practices at school and classroom level. The handbook also included the rationale of the project and clarified the role of the A&RTeam. It was made clear that the A&RTeam should provide support to school stakeholders in order to assist them in carefully setting up their own strategies and action plans for promoting not only quality but also equity. Thus, the aim of the handbook (produced by the A&RTeam) was mainly to help schools develop and implement their strategies and action plans, by providing concrete and specific guidelines to the teachers (the practitioners) and the school management team (principal and deputy heads). Specifically, the A&RTeam provided the aims, content, target groups and, most importantly, the activities and actions that

schools could carry out in order to promote equity. The handbook also provided clear suggestions on how to build school evaluation mechanisms, including the collection of relevant data, and the use of this information to promote quality and equity, both at the school and classroom levels. The handbook can be accessed from the web page of the project (www.ucy.ac.cy/equality).

At the next step of the intervention, the A&RTeam provided support to the schools to help them establish school evaluation mechanisms. In addition, the A&RTeam analysed the data that emerged from the pre-measure and provided feedback to each school indicating its priorities for improvement. School stakeholders had the chance to discuss the findings of school evaluation and decide whether their action plans would address one, or a combination of priorities concerning the factors included in the dynamic model. It was strongly recommended that decisions of their priorities for improvement should be taken not only by the teachers and the school management team. Students and parents should also be actively involved in the decision making process. For this reason, schools were encouraged to establish a committee with representatives of parents, students and teachers to discuss the results and gradually reach a consensus about the priorities of the school and how to deal with them. The final decision was announced to the whole school community and feedback was provided which helped schools to produce a clear definition of their improvement area.

At the third stage of the intervention, school stakeholders (in cooperation with the A&RTeam) developed their strategies and action plans addressing specific aspects of the domains that they were focusing on (readers may see the action plans developed by schools in the web page of the project). It was explicitly stated that the action plan should not only refer to the activities that should be taken, but should also indicate who was supposed to do each activity, what the time-schedule was and what resources were needed. At this point, the schools were also reminded to make use of the suggestions and additional reading sources provided in the handbook, in order to specify the activities of their improvement project. School stakeholders then had to divide the work on developing their action plans by appointing different groups or committees for specific areas. At all stages, and especially in developing action plans, members of the A&RTeam provided support to the school stakeholders.

Beyond designing action plans, school stakeholders were further asked to make decisions regarding the monitoring of the implementation of their strategies and action plans (see step E of DASI in Fig. 1). For example, some schools decided that a log book should be kept by the coordinator of the improvement effort, as well as from those stakeholders who were responsible for implementing specific aspects of their action plans. School stakeholders were also asked to share their experiences/views with the management team and other stakeholders. If a problem arose in implementing aspects of the action plans, school stakeholders (in cooperation with the A&RTeam) had to improve their action plans and/or provide support to those stakeholders not in a position to implement particular tasks of the action plans.

In the next stage, the intervention was implemented. The implementation of DASI lasted for approximately eight months and the A&RTeam provided support to the school stakeholders by helping them overcome difficulties and problems that emerged during the implementation of their action plans. Moreover, the A&RTeam helped school stakeholders to use the evaluation data in order to modify their strategies and action plans, according to the circumstances and specific needs of different groups of the school population. The apt modification of action plans was found to reduce the chance of a school discovering only too late that no progress was made through the school year, due to the poor implementation of its action plans.

5.3. Support offered to the schools of the control group

In order to evaluate the impact of DASI, the A&RTeam provided feedback to a control group of primary schools ($n=20$) about the results that emerged from a pre-measure concerned with student achievement in mathematics and the functioning of the school factors of the dynamic model. These schools were also supported to develop their own strategies and actions to promote quality and equity, without using the DASI. Support was, therefore, provided by the research team and the same amount of time and effort was allocated on each treatment group. In addition, accounts for the effort that schools put into the project were collected and we did not identify any statistically significant difference between the two groups in terms of the effort that the schools of these two groups put into the project. By following this approach we were able to provide equal support to each group and to control for the Hawthorne Effect in two ways: all experimental groups put the same amount of effort in their specific treatment and schools of each group were not aware of the other treatments avoiding compensatory rivalry or resentful demoralization by any of the group (Shadish et al., 2002). Thus, this group of schools was treated as a control group and data were collected in order to compare the impact of DASI on promoting quality and equity. The next part of this section refers to the methods used to measure the main variables of this study.

5.4. Measures

5.4.1. Student achievement in mathematics: prior and final achievement

For each year group of students, criterion-reference tests in mathematics were constructed in order to measure their knowledge and skills in mathematics in relation to the objectives of the national curriculum in Cyprus. The written tests were subject to control for reliability and validity. None of the respondents achieved full score, and none showed full zero performance. Moreover, less than 4% of the students achieved over 80% of the maximum score, and less than 10% of the students achieved over 70% of the maximum score. Based on the range of the results, the ceiling and floor effects in the attainment data were not observed.

5.4.2. Equating of tests

The test administered to Grade 6 students when they were at the end of the school year was obviously more difficult than the test administered to Grade 4 students when they were at the beginning of the school year. Prior to making comparison of test scores meaningful, the scores have to be made comparable. Equating was done using Item Response Theory (IRT) modelling. The method of equating follows the same procedure as that used in PISA studies. However, in PISA, equating is horizontal (equating the different versions of tests), whereas in this study the equating was vertical. Specifically, the scores were transformed into the same scale on the basis of characteristics of IRT models that students' latent level of ability (y) and difficulty level of an item (b) are identical when certain preconditions are fulfilled (Bond & Fox, 2001). The latent ability level for each student can be determined in every version as far as there are so-called anchoring items connecting the versions. For the purposes of this study, we used enough common items (i.e., approximately 15% of anchoring items across the tests) with representative content to be measured (Kolen & Brennan, 1995). Estimation was made by the Extended Logistic Model of Rasch (Andrich, 1988), which revealed that each scale had satisfactory psychometric properties. Thus, for each assessment period, achievement in mathematics was estimated by calculating the Rasch person estimates.

5.4.3. Student background factors

Information was collected on two student background factors: sex (0 = boys, 1 = girls), and SES. Five SES variables were available: father's and mother's education level, the social status of father's job, the social status of mother's job, and the economic situation of the family. Following the classification of occupations used by the Ministry of Finance, it was possible to classify parents' occupation into three groups: occupations held by working class (63%), occupations held by middle class (28%), and occupations held by upper-middle class (9%). Using Structural Equation Modelling (SEM) techniques, a first-order factor model was established based on these five variables measuring the students' SES. This model was found to fit the data (i.e., $X^2=9.4$, d.f. = 5, $p=0.094$; CFI = 0.961; RMSEA = 0.064) and thereby an indicator of SES emerged from this model.

5.4.4. Using a teacher questionnaire to measure school factors

The explanatory variables which refer to the school level factors of the dynamic model were measured by asking the teachers of the school sample to complete a questionnaire. The questionnaire was designed in such a way that information about the five dimensions of the school-level factors of the dynamic model could be collected and a Likert scale was used to collect data on teachers' perceptions of the school level factors (the questionnaire is available on the web page of the project, www.ucy.ac.cy/equality).

Since it is expected that teachers within a school view the policy of their school and the evaluation mechanisms of their school similarly, but differently from teachers in other schools, a Generalisability study was initially conducted. It was found that for all the questionnaire items, the object of measurement was the school. Then, reliability was computed for each of the dimensions of the school factors by calculating multilevel λ (Snijders & Bosker, 1999) and Cronbach alpha for data aggregated at the school level. The value of Cronbach alpha represents consistency across items whereas multilevel λ represents consistency across groups of teachers. The results are presented in Table 1. We can observe that for all factors and their dimensions the reliability coefficients were high (around 0.80).

Using the Mplus (Muthén & Muthén, 1999) software, the Intra-Class Correlations (ICC) of the scales were computed. The ICC, which indicate what amount of variance of the teacher questionnaire is located at the between level, are also illustrated in Table 1. We can observe that the percentages of variance at the between level (school level) were between 33 and 41. These percentages are rather high compared to other instruments that measure perceptions of people or objects in clustered or interdependent situations (den Brok, Brekelmans, Levy, & Wubbels, 2002). To test the validity of the questionnaire separate SEM analyses were conducted for each of the three overarching factors: a) *school policy on teaching*, b) *policy on the school learning environment*, and c) *school evaluation*. The first overarching factor is *school policy on teaching* and consists of the factors measuring quantity of teaching, provision of learning opportunities and quality of teaching (see Table 1). The second overarching factor is *policy on the school learning environment* and consists of the factors measuring student behavior outside the classroom, teacher collaboration, partnership policy and provision of sufficient learning resources. Finally, the third overarching factor is *policy on evaluation* and consists of the factors measuring evaluation of the school policy on teaching and evaluation of the learning environment. Additionally, for each of the three overarching factors (school policy on teaching, policy on the school learning environment and school evaluation) another model was tested in order to compare its fit to the data with the three proposed theoretical models. In these alternative models (models 2) all the items that were used for the SEM analyses in each of the three overarching factors were considered as belonging

Table 1
Cronbach Alpha (Reliability), Multilevel λ (Consistency), and Intra-Class Correlations (ICC) of scales emerging from teacher questionnaire concerned with each school factor at the school level.

School Factors	Cronbach Alpha (Reliability)	Multilevel λ (Consistency)	Intra-Class Correlations (ICC)
<i>School policy for teaching</i>			
Quantity of teaching	0.90	0.88	0.33
Provision of learning opportunities	0.89	0.83	0.31
Quality of teaching	0.92	0.82	0.38
<i>Policy on the school learning environment (SLE)</i>			
Student behavior outside the classroom	0.90	0.85	0.31
Collaboration and interaction between teachers	0.90	0.87	0.36
Partnership policy	0.92	0.84	0.34
Provision of resources	0.91	0.86	0.31
<i>School evaluation</i>			
Evaluation of school policy for teaching	0.93	0.88	0.35
Evaluation of the SLE	0.92	0.89	0.32

to a single factor. These models were an attempt to test whether the questionnaire items refer to a social desirability factor. If the one-factor models (models 2) were found to fit to the data, this would cause doubts on whether we could have scores per each factor separately. The fit indices of each model are shown in Table 2 where it can be seen that model 1 was found to best fit the data and that the fit indices of model 1 were satisfactory.

Having established the validity and reliability of the relevant measures, it was decided to generate the factor scores by taking into account teacher responses to the relevant questionnaire items. For each school, separate analysis of their teacher responses to the questionnaire items was conducted and those factors which had the lowest mean rank values were identified. The results were reported to each school and stakeholders of the experimental group were encouraged to develop their strategies and action plans in order to improve the functioning of those factors for which lower mean rank values were estimated (see step C of DASI).

6. Findings

Multilevel analysis of mathematics achievement was conducted in order to evaluate the impact of DASI on promoting quality. The first step of our analysis was to determine which levels had to be considered in order to reflect the hierarchical structure of the data. Empty models with all possible combinations of the levels of analysis (i.e., student, class and school) were established and the likelihood statistics of each model were compared (Snijders & Bosker, 1999). An empty model consisting of student, class and school levels represented the best solution. It was found that 62.4% of the total variance was situated at the student level, 23.5% of the variance was at the classroom level and 14.1% was at the school

level. In subsequent steps explanatory variables at different levels were added, starting at the student level. Explanatory variables, except grouping variables, were centered as Z-scores with a mean of 0 and a standard deviation of 1. Grouping variables were entered as dummies with one of the groups as baseline (e.g., boys = 0). The models presented in Table 3 were estimated without the variables that did not have a statistically significant effect at level 0.05. In model 1 the context variables at each level were added to the empty model. The following observations arise from the figures of the third column of Table 3. First, model 1 explained 32.1% of the total variance and most of the explained variance was at the student level. The likelihood statistic (X^2) revealed a statistically significant change between the empty model and model 1 ($p < 0.001$). Second, the effects of all contextual factors (i.e., SES, prior knowledge, sex, age) were significant. Prior knowledge in mathematics was found to have the strongest effect in predicting student achievement at the end of the school year. Moreover, prior-knowledge was the only contextual variable which had a significant effect on student achievement when aggregated either at the classroom or the school level. In model 2 the impact of DASI was tested by adding to model 1 a dummy variable. By considering the control group as a reference group, it was found out that the group which made use of DASI managed to receive better results and better than the control group. But although the effect of DASI on achievement was found to be statistically significant at 0.05 level, its effect size was small (i.e., $d = 0.11$).

To investigate the impact of DASI on promoting equity, for each group of schools two separate multilevel analyses were conducted to identify the impact of SES on student achievement in mathematics. The final models that emerged from each analysis are presented in Table 4. The results of the two separate multilevel

Table 2
Fit indices of the models emerged from the SEM analyses of the teacher questionnaire used to measure each overarching school factor.

Models	X^2	Df	X^2/df	p	CFI	RMSEA	Range RMSEA
<i>School policy on teaching</i>							
Model 1	143	16	8.9	0.001	0.984	0.052	0.045–0.060
Model 2 (one factor model)	484	20	24.2	0.001	0.943	0.090	0.083–0.097
<i>Policy on the school learning environment</i>							
Model 1	669	96	6.9	0.001	0.963	0.052	0.045–0.060
Model 2 (one factor model)	3879	135	24.2	0.001	0.759	0.098	0.095–0.101
<i>School evaluation</i>							
Model 1	585	57	10.2	0.001	0.967	0.057	0.053–0.061
Model 2 (one factor model)	1600	65	24.6	0.001	0.905	0.090	0.087–0.094

Table 3

Parameter Estimates and (Standard Errors) for the analysis of student achievement in mathematics (students within classrooms within schools).

Factors	Model 0	Model 1	Model 2
Fixed part (Intercept)	−3.17 (0.57) [*]	−2.21 (0.49) [*]	−1.71 (0.39) [*]
Student Level			
Context			
Prior Measure		0.65 (0.04) [*]	0.65 (0.04) [*]
Age		0.21 (0.05) [*]	0.21 (0.05) [*]
SES		0.26 (0.08) [*]	0.25 (0.08) [*]
Sex (0 = boys, 1 = girls)		0.10 (0.03) [*]	0.09 (0.03) [*]
Class Level			
Context			
Average prior achievement		0.35 (0.08) [*]	0.34 (0.07) [*]
Average age		0.10 (0.04) [*]	0.10 (0.04) [*]
Average SES		0.05 (0.05)	0.06 (0.05)
Percentage of girls		0.03 (0.04)	0.04 (0.04)
School Level			
Context			
Average prior achievement		0.26 (0.11) [*]	0.26 (0.10) [*]
Average SES		0.03 (0.05)	0.01 (0.05)
Average age		0.04 (0.04)	0.05 (0.05)
Percentage of girls		0.01 (0.03)	0.01 (0.03)
Intervention (DASI = 1, Only feedback = 0)			0.13 (0.04) [*]
Variance components			
School	14.1%	8.9%	7.0%
Class	23.5%	16.5%	15.8%
Student	62.4%	42.5%	42.5%
Explained		32.1%	34.7%
Significance test			
χ^2	9558.8	8434.0	8403.0
Reduction		1124.8	31.0
Degrees of freedom		7	1
p-value		0.001	0.001

^{*} Statistically significant effect at level 0.05.

analyses of student achievement at the beginning of the intervention are presented in the second and fourth columns of the table. Each analysis revealed that all background factors (i.e., SES, age and gender) were associated with achievement at the beginning of the intervention of each group of students. Moreover, SES was the only background factor found to be associated with student achievement when aggregated either at the level of class or school. Finally, the results of the two analyses were exactly the same in terms of the background factors found to be associated with achievement at the beginning of the intervention of the two groups of students and were almost the same in terms of the percentage of explained variance of student achievement of each group of students (i.e., 23.8% and 24.2%). In order to estimate the relative importance of the SES on student achievement at the beginning of the intervention for each group of students, the fixed effect obtained with each multilevel analysis was converted to standardised effects or “Cohen’s *d*” by following the approach proposed by Elliot and Sammons (2004). This approach investigates the change on the outcome measure that will be produced by $\pm$ one standard deviation on the continuous predictor variable (i.e., SES), standardised by the within school standard deviation adjusted for covariates in the model. In this way, the relative strength of the effect of SES for each group of students can be compared. By using this approach, it was found that the effect size was equally high for each group of students (i.e., experimental group: $d = 0.44$ and control group $d = 0.45$).

The results emerged from analyzing the impact of student background factors on achievement at the end of the intervention for each group of students are presented in the third and fifth columns of Table 4. For each group of students, achievement at the

end of the intervention was found to be associated with all student background factors (i.e., prior achievement, SES, age, sex). Moreover, the findings of both analyses show that prior achievement was the only background factor associated with achievement at the end of the intervention when aggregated either at the level of class or school. Thus, the two separate analyses of achievement at the end of the intervention reveal exactly the same results in terms of the background factors found to be associated with achievement. However, a difference in the percentage of explained variance of achievement at the end of the intervention was observed since in the case of the control group this percentage was found to be higher. Finally, in regard to the effect of SES on student achievement at the end of the intervention, using the approach described above it was found that for students of the control group the effect size of SES was stronger ($d = 0.38$) than for students of the experimental group ($d = 0.27$).

7. Discussion

Implications of findings for research, policy and practice are drawn. First, previous studies revealed that DASI had an effect on promoting student learning outcomes. However, improving quality without equity risks leading large economic and social disparities. Nevertheless, this study seems to reveal that by using DASI not only student learning outcomes can be promoted but also learning differences between students coming from different socioeconomic backgrounds may be reduced. The findings of this study show that in the schools of the experimental group the impact of SES on student achievement became smaller. These findings indicate that DASI may have an effect on promoting not

Table 4

Parameter Estimates and (Standard Errors) for the analysis of the impact of SES on student achievement in mathematics (students within classrooms within schools).

Factors	Experimental Group		Control Group	
	Pre-measure	Post-measure	Pre-measure	Post-measure
Fixed part (Intercept)	–3.12 (0.84) [*]	–2.10 (0.59) [*]	–3.21 (0.99) [*]	–2.40 (0.63) [*]
Student Level Context				
Prior Measure	NA [*]	0.60 (0.04) [*]	NA [*]	0.63 (0.05) [*]
Age	0.29 (0.11) [*]	0.20 (0.05) [*]	0.27 (0.10) [*]	0.21 (0.05) [*]
SES	0.41 (0.10) [*]	0.15 (0.08) [*]	0.40 (0.11) [*]	0.29 (0.08) [*]
Sex (0 = boys, 1 = girls)	0.10 (0.05) [*]	0.11 (0.05) [*]	0.14 (0.06) [*]	0.14 (0.05) [*]
Class Level Context				
Average prior achievement	NA [*]	0.32 (0.08) [*]	NA [*]	0.37 (0.09) [*]
Average age	0.16 (0.09)	0.10 (0.04) [*]	0.14 (0.08)	0.11 (0.04) [*]
Average SES	0.17 (0.07) [*]	0.05 (0.05)	0.15 (0.06) [*]	0.06 (0.05)
Percentage of girls	0.11 (0.05) [*]	0.03 (0.04)	0.12 (0.05) [*]	0.05 (0.04)
School Level Context				
Average prior achievement	NA [*]	0.24 (0.10) [*]	NA [*]	0.27 (0.10) [*]
Average SES	0.09 (0.04) [*]	0.04 (0.05)	0.10 (0.04) [*]	0.06 (0.05)
Average age	0.09 (0.06)	0.03 (0.04)	0.08 (0.07)	0.03 (0.04)
Percentage of girls	0.03 (0.05)	0.01 (0.03)	0.04 (0.05)	0.02 (0.03)
Variance components				
School	10.1%	11.2%	10.7%	7.9%
Class	21.8%	20.4%	21.6%	12.4%
Student	44.3%	42.0%	43.5%	41.4%
Explained	23.8%	26.4%	24.2%	38.3%
Significance test				
X ²	8321.5	7932.1	8241.7	7532.1
Reduction	809.4	989.5	832.6	989.2
Degrees of freedom	6	6	6	7
p-value	0.001	0.001	0.001	0.001

^{*} There was no measure of prior achievement that could be used in analyzing student achievement at the beginning of the intervention.^{*} Statistically significant effect at level 0.05.

only quality but also equity. Although previous studies revealed stronger effect sizes of DASI on promoting student learning outcomes (the average effect size on student achievement was around 0.25), this study took place in socially disadvantaged schools. In general school improvement interventions in this type of schools are less likely to promote student learning outcomes (Sammons, 2010; Townsend, 2007). Thus this study may reveal the potential of DASI to promote quality and equity especially since by using DASI for just one school year statistically significant effects on quality and equity in mathematics were identified in socially disadvantaged schools. However, further research is needed to investigate the impact of using DASI for a longer period on promoting quality and equity. Studies investigating the sustainability of DASI are also needed since school stakeholders may have to face special challenges in using this approach in socially disadvantaged areas for a long period.

The findings of this project are also in line with the results of studies investigating the impact of the Comprehensive School Reform program (CSR) on student achievement (Rowan et al., 2009). The approach proposed in this project has some common characteristics with the CSR program which attempts to use a “school improvement by design” approach to encourage schools to work with outside agencies and implement new designs for educational practice. An evidence-based approach to school improvement is encouraged (Slavin & Fashola, 1998). A meta-analysis investigating the achievement effects of CSR reveals that the schools which implemented CSR models for five years or more had particularly strong effects on achievement and the benefits were consistent across schools of varying poverty levels (Borman

et al., 2003). Given that the implementation of the intervention took place for only one school year, it can be claimed that the results about the effect of DASI to promote quality and equity are promising especially when one takes into account that CSR projects do not demonstrate strong effects on equity and were implemented for a longer period. At the same time, suggestions for further research can be drawn. Longitudinal studies, involving both quantitative and qualitative research methods, could be conducted in order to provide answers on questions dealing with the short and the long term effect of DASI upon promoting quality and equity. These studies may also identify contributory and inhibitory factors to the sustainability of this approach.

When related to the development of educational policy, policy-makers have to be aware that DASI can never be used as a recipe for effective school improvement or as a ready-made toolbox for the implementation of improvement in schools. As has been demonstrated in this paper, DASI merely clarifies or prescribes which factors should be taken into consideration in the planning of improvement processes in schools. DASI emphasises the central place of the school, based on effectiveness and improvement theories, and on the basis of the study presented in this paper we can claim that effective improvement requires school-level processes. Nevertheless, the framework does not dictate what those processes might be in any individual school. On the other hand, leaving schools to improve on their own might not be a realistic or, most importantly, an effective option (Creemers & Kyriakides, 2010b). From this perspective, DASI may help policy-makers to understand the importance of utilising theory-driven and evidence-based approaches to school improvement, as they

have the best potential for making a significant contribution to the improvement of student learning outcomes and the reduction of learning differences between students coming from different socioeconomic backgrounds. It can also help policy-makers to realise how important school improvement is for promoting quality and equity or how important the school is as a meaningful unit for improvement.

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