IFIP AICT 400

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(Eds.)

Next Generation of Information Technology in Educational Management

10th IFIP WG 3.7 Conference, ITEM 2012
Bremen, Germany, August 2012
Revised Selected Papers

Springer

IFIP Advances in Information and Communication Technology 400

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- Open conferences;
- Working conferences.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

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Any national society whose primary activity is about information processing may apply to become a full member of IFIP, although full membership is restricted to one society per country. Full members are entitled to vote at the annual General Assembly, National societies preferring a less committed involvement may apply for associate or corresponding membership. Associate members enjoy the same benefits as full members, but without voting rights. Corresponding members are not represented in IFIP bodies. Affiliated membership is open to non-national societies, and individual and honorary membership schemes are also offered.

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ISSN 1868-4238 e-ISSN 1868-422X
ISBN 978-3-642-38410-3 e-ISBN 978-3-642-38411-0
DOI 10.1007/978-3-642-38411-0
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2013937792

CR Subject Classification (1998): K.3, K.4, H.5

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Next Generation of Information Technology in Educational Management

This book offers a selection of papers presented at the latest international conference of Working Group 3.7 of the International Federation for Information Processing (IFIP). This conference, the 10th international conference organized by the Working Group, focused on an important contemporary issue – the next generation of information technology in educational management.

The conference sought to achieve a wider understanding of factors related to and influencing this issue, taking opportunities to consider current practices, concepts and research directions in this topic area. The conference drew on a wide range of expertise and research studies, from across Australia, Europe, and the USA. The conference built on and developed key points and concerns raised in the two conferences immediately preceding this one:

- Evolution of information technology in educational management, which focused on ways information technology has been involved in and supported educational management over a period of 20 years, and the changes seen over that period of time (considered in depth in the international conference in Darwin, Australia, in 2008)
- Information technology and managing quality education, which focused on ways information technology has been used to support enhanced qualities of educational management and its outcomes in terms of effective and improved teaching and learning (explored in the international conference in Kasane, Botswana, in 2010)

Taking these concerns forward, the international conference in Bremen, Germany, focused on the topic of the next generation of information technology. From this conference, four key questions arose:

- Why do we need new educational management information systems?
- What issues do those developing new educational management information system face?
- What new educational management information systems are being developed?
- What educational management systems are already in place?

This book takes these four key questions in turn, and presents papers enhancing our understanding and appreciation of these issues, as well as details concerned with implications and factors seen to be emerging at this time. These papers offer

an outstanding overview of this contemporary field, bringing together complementary study outcomes and positional perspectives to help frame our research within wider policy and practice dimensions.

Why do we need new educational management information systems?

- Staman, Visscher, and Luyten argue that data management can support school improvement practices, at student, teacher, classroom and school levels, and that it is vital for key stakeholders to be trained and to use data appropriately from educational management information systems to support school improvement for the benefit of learners.
- Passey highlights the important roles of discussion in managing educational improvement, and how data management can support discussions between teachers, teachers and students, and parents, teachers and students, that can both support vital decision making and inform monitoring practices to enhance learning approaches, practices and outcomes.
- Schildkamp, Karbautzki, Breiter, Marciniak, and Ronka report on ways data can be framed and conceptualized to support users in schools in developing management practices to enhance teaching and learning, and on this basis propose training programs to support effective use of data in schools.

What issues do those developing new educational management information system face?

- Breiter, Groß, and Stauke present evidence of the key issues facing those attempting to implement and adopt wide-scale e-assessment processes using technologically based systems, and potential implications for those wishing to consider the feasibility or development of these practices further.
- Tanrikulu provides evidence from experts working in the field of e-assessment in higher education, identifying factors both supporting and hindering processes of wider integration and implementation of e-assessment practices, raising implications for those resourcing developments in this field.
- Celep and Konaklı provide evidence from school teachers about current knowledge management practices, and highlight the importance of administrative support and background characteristics on levels and forms of knowledge management processes, raising questions about aspects where future developments could support more effective organizational learning in schools.
- Mohamad, Manning, and Tatnall provide evidence about knowledge management practices in another sector of education, in the administration of higher education in Malaysia, and again highlight factors that could contribute to enhanced organizational learning and practices, considering particularly the influences of cultural factors and adoption decisions.
- Thorn provides evidence of how data management systems are currently being adapted to inform decisions on teacher pay performance through the teacher incentive scheme in the USA, and highlights key issues and concerns

to be addressed if this form of program is to be supported more effectively through data management systems aligned to social systems in the future.
- Schulz and Breiter explore the use of logfiles derived from school information systems as ways to analyze patterns and uses, to inform at levels of awareness and outcome, while identifying not only ways these data are currently being used but also limitations and implications for future uses and development.

What new educational management information systems are being developed?

- Strickley describes how data links between national data sets enabled wider transfer between local and national government systems in the United Kingdom, enabling access through an information system that could support citizens more considerately, effectively and efficiently when seeking and receiving allocated funding to support their children with free school meals.
- Castro and Santos describe the processes and procedures used to build from an existing, and develop a new, information system to support schools with specified and different forms and levels of data, linked to key performance indicators.
- Pereira and Castro present a case study that describes the conceptual and practical approaches used to identify and select technology partners for developing school information systems, accommodating the needs of all key stakeholders, and using a systematic approach to the needs to develop appropriate decision making.
- Lämmerhirt, Franssen, and Becker describe processes and procedures involved in conceptualizing, developing, and implementing a campus-wide data management system to support higher educational needs in their university, initiated through business process modeling, requirements analysis, integrating organizational processes, and procuring and developing a new information management system.

What educational management information systems are already in place?

- Casey describes the data information systems in place across a county in Norway, where data are held in a variety of government data bases, and transferred in order to support all stakeholders across the secondary school sector.
- Tatnall and Davey describe a learning management system developed and implemented across the entire school sector in Victoria, Australia, identifying features that are successful and those where further focus is needed to enhance future practices for students, teachers, and parents.
- Gregor, Wilmes, and Kiock describe the development and implementation of a data management system to support school planning needs across Berlin, Germany, highlighting the fundamental roles of those involved, and the vital need to accommodate personal and ethical regulations laid down in statutes.

All papers in this book were peer-reviewed, and authors were able to use reviewer, presentation audience, and editor feedback in order to finalize the chapters presented here. We, the editors, wish to thank our authors for contributing to this book, which we believe will help to stimulate wider consideration for those working in this field, whether they be researchers, policy makers, or practitioners.

March 2013

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Part III: What New Educational Management Information Systems Are Being Developed?

Part IV: What Educational Management Information Systems Are Already in Place?

Note of Apology

The authors and editors of a paper presented in the previous IFIP AICT 348 volume entitled *Information Technology and Managing Quality Education* sincerely apologise for the omission of two authors' names. The paper offered in Chapter 10 of that volume should read, on both pages IX and 95:

Bridging the Knowledge Gap for African Researchers through Open Access Publishing: The Case of African Higher Education Research Online (AHERO)
Beatrice Sekabembe, Jude Ssempebwa, Shehaamah Mohamed and Allison Fullard

Part I

Why Do We Need New Educational Management Information Systems?

The Effects of Training School Staff for Utilizing Student Monitoring System Data

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Abstract. The Dutch School Inspectorate defines achievement-oriented work (AOW) as the maximization of student performance in a systematic and goal-oriented way. Research by the Inspectorate shows that students in achievement-oriented schools perform better than students in schools that meet the criteria for achievement-oriented work less. The University of Twente has developed a training course in which school teams learn to work in an achievement-oriented way. Parallel to the training activities, the effects of training schools are studied. The research findings show that the training course has a positive effect on attitudes towards AOW, as well as on knowledge and skills relevant for AOW of school staff.

Keywords: Achievement-oriented work, student monitoring system, professionalization, data use, evaluation.

1 Introduction

Growing attention for achievement-oriented work (AOW) in Dutch primary education is caused by the supposed declining performance of Dutch students in the core subjects: arithmetic, language and reading. Research by the Dutch School Inspectorate [1] shows that students in AOW-schools perform better. The assumption is, therefore, that performance in Dutch schools in the core subjects can be improved if Dutch schools in general adopt the AOW approach. Achievement-oriented schools are supposed to use the results of evaluations of student performance (by means of student monitoring systems) for maximizing student performance by working in a more goal-oriented way and by adapting instruction in such a way that it meets students' needs as much as possible [2]. The research by the Inspectorate shows that the degree of AOW varies between schools. Only 30% of all primary schools operate in an AOW-way, and the majority of schools can improve its AOW-skills a great deal. This especially applies to analyzing student performance and diagnosing causes of underperformance, formulating challenging goals for all students, and adapting instructional activities to students' educational needs. Promoting AOW requires teacher professional development, and the development of an achievement oriented school organization [3, 4, 5, 6]. Based on the research of the Inspectorate with regard to the level of AOW, the conclusion can be drawn that in most Dutch primary schools

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 3–14, 2013.

AOW is not a reality yet. The Ministry of Education supports, however, various initiatives for promoting AOW. One of these initiatives is the development of a training course for primary schools in which schools learn to work in a systematic and achievement-oriented manner. This so-called 'Focus-project' aims to improve student performance in Dutch primary education by means of a two-year training course in which schools learn to utilize student monitoring system data, formulate challenging performance goals, and to provide instruction that is adapted to students' instructional needs.

2 Theoretical Framework

Achievement-oriented work is equivalent to what in other countries is called 'data-driven teaching' (i.e. [7]). In many countries student performance data for improving student performance is promoted by the accountability contexts of schools [6]. Schools are held responsible for the performance of their students, and are supposed to monitor and optimize student performance systematically [8]. Analyzing student data in depth can point to specific problems of schools, teachers and groups of students [9]. According to Carlson, Borman and Robinson [10] an achievement-oriented approach includes collecting, interpreting, and distributing data, which could support school improvement initiatives. The literature on school improvement and

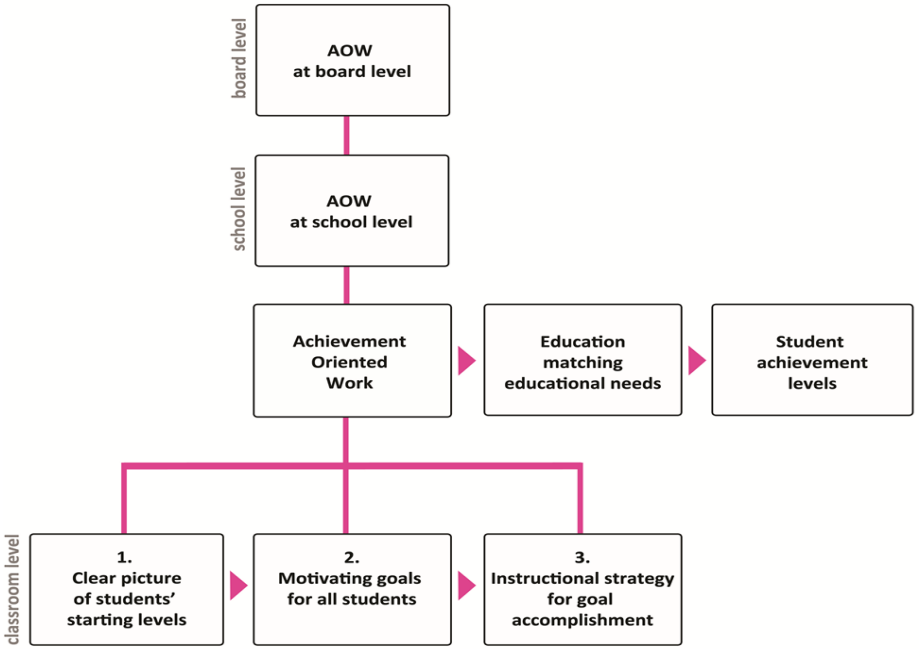

Fig. 1. Achievement-oriented work at various levels

school effectiveness also points to the central role of using student assessment data within school improvement processes [11, 12]. In the view of Perie, Marion and Gong [13] test data can be used in three ways:

- as a tool for teachers in adapting instruction and the curriculum to the needs of students;
- for evaluating and improving instruction; and
- for predicting students' test scores on future tests.

Using test data can also lead to a more professional school culture and more cooperation within schools [14]. As a result, communication and knowledge within schools increase, and data use can improve teachers' attitudes towards providing instruction for students [15]. Visscher and Ehren [4] explain the mechanisms through which AOW at the school level can promote better education and student results. A good image of the starting situation of the students, formulating challenging goals based on that information, and choosing a route for accomplishing the goals set at the school, grade and student level are all required. Achievement-oriented work as such touches the whole school organization (see Figure 1; note that in this Figure, board level indicates the school board level).

2.1 Achievement-Oriented Work at the School and Classroom Level

Goertz, Olah and Riggan [5] show that leadership and an achievement-oriented school culture in combination with support from local government are critical factors in assisting teachers with AOW. The literature on school improvement stresses the positive relationship between distributed leadership and school innovation. Hulpia [16] describes distributed leadership from three different perspectives: as a distribution of leadership functions; as cooperation between the members of a management team; and as participative decision-making by teachers. The role of teachers in decision-making processes and the contribution of strong, collegial relationships are mentioned as important prerequisites for school improvement [17]. In the view of Earl [18] and Sutherland [19] distributed leadership in addition to supporting AOW can contribute to school improvement. School leaders can fulfill an important model function here. They should stimulate and support their school staff for AOW [19]. In an achievement-oriented school culture, high performance of all students in the core subject is considered important. Furthermore, achievement-oriented work is influenced by the degree to which school staff are offered opportunities to cooperate within the school. Additionally, a school leader is supposed to promote a shared vision, norms and school goals, as a climate in which data are used for school improvement (instead of using the data for evaluating teacher performance). A school leader can also facilitate the work of his/her team members by providing time for, for example, collecting, analyzing and interpreting data. Conrad and Eller [20] note that the implementation of AOW requires intensive professional development interventions for teachers and school leaders. Finally,

a combination of pressure and support is supposed to promote AOW [6]. Diamond and Spillane [21] and Slavin [22] stress that external pressure, for example through the governmental accountability policy in combination with support, provides the best opportunity for innovating the school organization. In the view of Visscher and Ehren [4] this also applies to the role of the school leader. Within AOW the school leader ideally monitors the AOW innovation process and stimulates all team members to do their best to implement the three components of AOW at the classroom level (see Figure 1), and by supporting them where necessary.

Component 1: An Accurate Picture of Students' Starting Situations. According to Visscher and Ehren [4], the first important activity in an achievement-oriented approach is obtaining a good image of the actual performance level of students. Schools for that purpose have to collect test data at the school level on how the school functions. These test data can be compared with previous test data on the performance of the school as a whole, about grades, and individual students. Comparisons with national average performance are also possible. In addition to this, analyses can be made of which specific components of subject matter are mastered by students or not [23]. Test data should also lead to further analysis of causes of specific student results. A student monitoring system can support these activities. Performance feedback can be an important tool for school improvement. Research by Chen, Heritage and Lee [24] shows that school information systems can assist school staff in timely finding of students at risk which can help in adapting instruction to students' instructional needs, and higher student achievement levels [25, 26]. The positive effects of performance feedback on performance improvement have been reported repeatedly [27, 28, 29]. However, Hattie and Timperley [28] point to the fact that feedback effects are not always positive. The effects depend, for example, on the context in which the feedback is provided and the way in which it is provided. In order to have a positive effect, the feedback should be corrective (showing what is wrong and why) and show how the feedback recipient can improve his/her performance. About 90% of Dutch primary schools use one or more components of the CITO student monitoring system [3]. By means of a student monitoring system, achievement can be monitored on a longitudinal basis across the whole primary school at the level of individual students, grades and schools. The basis of the system is provided by high quality standardized tests for primary school students which are taken twice (in most cases: at the end of a school year, and half way through the school year) or once a school year. The system supports the analysis of the performance of individual students, student cohorts (for one test, or across all tests taken for a cohort), or classes (for one test taken, or across all tests taken for this class). The system not only supports the analysis of the performance level of students in comparison with the national benchmark but also the analysis of which components of the subject matter a student masters and which not (which is very important for designing instruction). As student performance as measured by means of all the tests taken can be expressed on one and the same scale, the monitoring system allows the added value between two or more measurement moments to be determined.

This is important for analyzing how much a student learns in a specific period of time (e.g. a school year) as a student may perform at a relatively high level but not have grown much in that period of time. Similarly, it is also valuable knowing that a student who performs at a relatively low level has grown a lot since the previous test taken.

Component 2: Setting Goals for All Students. According to Visscher and Ehren [4] the second component of AOW includes formulating desired performance levels in terms of explicit and clear goals for individual students and the school as a whole. Locke and Latham's goal setting theory [30] states that explicit, specific and challenging goals lead to higher performance. Difficult goals require more effort and dedication than easy goals. Such goals steer behavior, and in general hard goals motivate people to accomplish those goals. In addition, definitions of success vary less if goals are formulated explicitly and clearly as the goals in that case indicate precisely when they are accomplished and when not. Locke and Latham [30], however, also stress the importance of self-efficacy in the context of goal-setting. Higher self-efficacy levels are proven to lead to higher goals while more goal-ownership leads to more searching for goal attainment strategies [31]. The combination of goal-setting and providing feedback proves to be more effective than the sum of the effects of each of these two activities. Based on the feedback, the strategies applied for accomplishing the goals set can be evaluated and improved.

Component 3: Determining the Route for Goal Accomplishment. The third step in the model of Visscher and Ehren (see Figure 1) includes taking decisions with respect to the instructional strategies that will be used for accomplishing the goals set. Research by Heritage et al. [32] shows that teachers are more capable of interpreting assessment data than they are of taking decisions on the desired nature of instruction based on assessment data. What is needed at this stage is deliberate practice: ideally teachers carefully and professionally take decisions on how instruction will look, based on student progress information (which will vary between students) instead of working in a routine way regardless of student progress details. Next to deciding on how instruction should look, teachers should evaluate the effects of instructional decisions taken. According to Massell [15], using assessment data for taking instructional decisions is a very complex task and in most cases teachers have not been prepared for taking such decisions.

2.2 The Practice of Achievement-Oriented Work

Based on the research on AOW, the conclusion can be drawn that AOW has not been implemented in many schools yet [3] and that the expertise of school leaders, school internal coaches and teachers regarding AOW is limited. Especially lacking are the skills and knowledge for analyzing and interpreting assessment data, as are the taking of decisions based on the assessment data with regard to how to adapt instruction to students' educational needs. There is also much room for improvement regarding formulating specific measurable goals at the school and classroom level.

Schildkamp and Kuiper [6] and Wayman [33] conclude that AOW can be promoted by means of training and supporting school staff. School staff themselves also indicate the need of support in the context of AOW [34].Teachers' attitudes regarding the effectiveness of interventions prove to be very important for the effectiveness of school improvement initiatives [35, 36]. Their attitudes influence their efforts and enthusiasm. More specifically, various authors stress the importance of a positive attitude towards school performance feedback [37]. Training school staff can have a positive effect on the attitudes of school staff towards school performance feedback, and on the knowledge and skills for using the feedback [38].

3 Research Question

In 2010 a longitudinal study was started, looking at the effects of the Focus training course for AOW on the basis of school performance feedback in 86 Dutch primary schools. The effects of the training course on the knowledge and skills and attitudes of school staff with respect to AOW have been investigated.

The data acquired have been used to answer the following research question: What effects does the Focus training course have on school staff's knowledge and skills with respect to the student monitoring system they have, as well as on their attitudes towards the use of the student monitoring system and AOW?

4 Research Method

Schools were approached for participation in the Focus-project and all but one school was located in the Twente/Salland region in the Eastern part of the Netherlands. Schools participated in the Focus training project in the school years 2010 to 2011 and 2011 to 2012. Data from the pre-test and post-test were available with regard to knowledge and skills and attitudes concerning AOW for the participants in the school year 2010 to 2011 (54 school leaders, 55 internal coaches and 578 teachers in grades 1 up to and including grade 5). In the school year 2011-2012, school leaders, internal coaches and teachers in grades 6, 7 and 8 participated in the training course. A number of schools had an auxiliary branch which could be considered to be a school in itself, as a result of which the total number of experimental schools was 48.

4.1 Instruments for Data Collection

Instruments used for measuring knowledge and skills, and attitudes to AOW were:

- a test measuring skills to interpret student monitoring system data;
- a test measuring knowledge about various ways to use the student monitoring system;
- an instrument measuring general attitude towards AOW;
- an instrument measuring attitude towards Focus components of AOW; and
- an instrument measuring attitude towards student monitoring system use.

4.2 The Intervention

As mentioned in previous sections, Visscher and Ehren [4] distinguish between three AOW components: obtaining an accurate image of the students' starting situation; setting goals for all students; and choosing the route for accomplishing the goal set. The schools were trained to transform analyzed test data into an action plan (a group plan including learning and performance goals for all students as well as the didactical approaches for accomplishing the goals set). The Focus cycle for AOW included the analysis and diagnosis of test data, formulating action plans (group plans), and monitoring and evaluating the execution of this plan. The various components of the cycle had been specified in a protocol which included twelve steps. This protocol was filled out by schools twice a year (after the end-of-school-year test and the test taken after half a school year). Figure 2 presents the various components of the cycle, including the various steps in the protocol. In steps 1 - 6 teachers/schools are shown the various forms of performance feedback the student monitoring system can provide: data on the performance of students and student groups at one or more measurement moments. Thereafter, causes for underperformance are diagnosed using information about learning progression as well diagnostic conversations with individual students. Based on all the information available, teachers draw up group plans for their student groups in which they specify how each student in the group performs, how each student ideally will perform when the next test is taken, and which didactical approach will be used for each student to transform actual performance to a desired performance (step 10). Next, the group plans are carried out (step 11) and after some time the results are evaluated to determine whether the didactical strategy works. If not, the group plan is adapted to increase the probability of success.

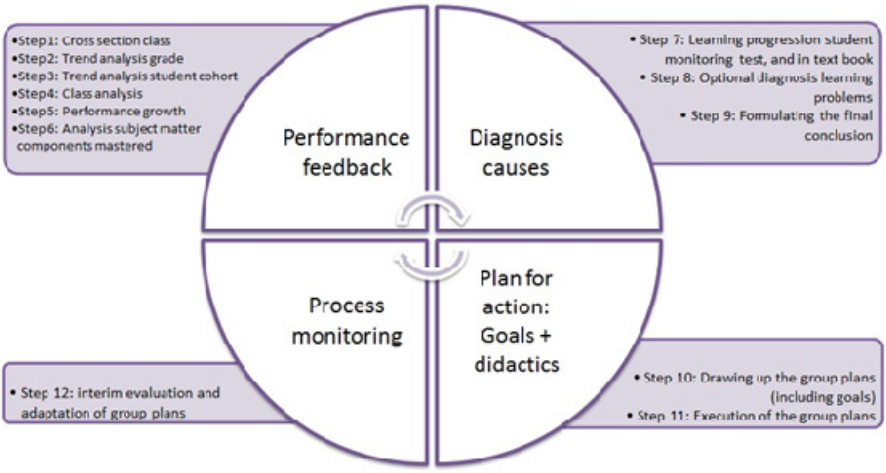

Fig. 2. The Focus AOW cycle showing activities in the protocol at each stage

4.3 Data Collection Procedure

Knowledge and skills about the student monitoring system, and attitudes towards AOW were measured during Focus training sessions. In the case of knowledge and skills about the student monitoring system, respondents were asked to answer multiple choice questions (developed by the researchers based on their knowledge of the student monitoring system) about the types of data analysis the monitoring system allows, and about what the data mean.

Respondent's attitudes were measured by means of statements about the value of achievement-oriented work, and the use of a student monitoring system. The respondents were asked to indicate to what extent(s) they agreed with each of the statements.

4.4 Data Analysis

Because of their nested structure (students nested in groups and teachers nested in schools) the data were analyzed by means of multilevel analysis techniques. In the case of measuring respondents' knowledge and skills about the student monitoring system, the number of correct answers on the pre-test and the post test was computed and compared to analyze the effects of the training activities. Differences between attitudes towards achievement-oriented work and the student monitoring system on the pre-test and the post- test were also computed. Only the data for respondents participating in the pre-test as well as the post-test were included in the analysis.

4.5 Results

The results point to a remarkable difference within and between schools with respect to the degree to which staff had acquired required knowledge and skills for AOW, and attitudes (motivation) towards AOW. Table 1 presents results of multi-level analyses.

Statistically significant differences between the post-test and the pre-test were found for 'Knowledge student monitoring system' (the correct interpretation of the data) ($t = 11.46$, $p < 0.001$), and 'Knowledge student monitoring system' (the various analyses that can be made by means of the system)' ($t = 16.28$, $p < 0.001$). Furthermore, school leaders differed significantly from teachers on the pre-test with regard to the variable 'Knowledge student monitoring system' (interpretation) ($t = 2.87$, $p < 0.010$) and 'Knowledge student monitoring system' (possibilities) ($t = 3.20$, $p < 0.010$). On the pre-test, school leaders proved to know more about how the student monitoring system could be and should be (with correct interpretation) used. On the post-test, school leaders differed significantly from teachers in terms of their growth in knowledge with regard to how the student monitoring system output should be interpreted ('Knowledge student monitoring system) ($t = -2.06$, $p < 0.050$).

Table 1. The growth in knowledge and skills, and attitudes towards AOW

Fixed Effects													Random Effects					
Dependent variable	Intercept		School leader		School leader * Time		Internal Coach		Internal Coach * Time		Time		Level 3 (school)		Level 2 (respondent)		Level 1 (measurement)	
	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.	Effect Estimates	S.E.
Knowlede SMS (interpretation)	47.80	2.44	14.82**	5.16	-12.67*	6.15	14.61***	4.06	-8.75	5.15	23.33***	2.03	68.73*	31.57	41.03	23.07	168.14***	23.38
Knowledge SMS (possibilities)	47.22	1.52	10.66**	3.33	-7.09	4.26	7.45**	2.72	-6.31	3.37	24.73***	1.52	31.97*	12.45	49.55**	17.10	183.53***	17.47
General attitude AOW	40.25	.48	2.45*	1.00	.40	1.23	2.09*	.93	-.64	1.13	1.40**	.49	3.02*	1.26	3.76*	1.70	19.42***	1.87
Attitude Focus components AOW	13.94	.54	1.42	1.27	-4.02*	1.82	.48	1.16	-1.18	1.60	-1.79*	.72	1.03	.18	-	-	43.84***	2.93
Attitude SMS use	15.93	.39	1.26	.94	-1.36	1.28	1.01	.86	.35	1.14	1.53**	.51	.46	.60	1.64	2.07	21.88***	2.36

* significant at $p < .05$, ** significant at $p < .01$, *** significant at $p < .001$
SMS = student monitoring system

School leaders grew less than teachers but already had a higher score on the pre-test. Internal coaches also proved to differ significantly from teachers on the pre-test. They seemed to know more already about AOW: 'Knowledge student monitoring system (interpretation)' ($t = 3.60$, $p < 0.001$); and 'Knowledge student monitoring system (possibilities)' ($t = 2.74$, $p < 0.010$). Internal coaches did not grow significantly less or more than teachers on these variables.

The scores on the post-test for the variables 'General attitude towards AOW' ($t = 284$, $p < 0.010$), 'Attitude towards the Focus AOW components' ($t = -2.48$, $p < 0.050$), and 'Attitude towards student monitoring system use' ($t = 2.98$, $p < 0.010$) proved to differ significantly from the attitudes measured by means of the pre-test. The general attitude towards AOW and the attitude towards the student monitoring system use improved significantly whereas the attitude towards the Focus AOW components was lower on the post-test.

The results differed somewhat between the various types of school staff. School leaders and internal coaches were more positive towards AOW than teachers on the pre-test (for school leaders $t = 2.45$, $p < 0.050$; for internal coaches $t = 2.25$, $p < 0.050$). Moreover, school leader attitudes towards the Focus AOW components were lower on the post-test than teachers' attitudes towards the Focus components of AOW ($t = -2.22$, $p < 0.050$).

5 Conclusion and Discussion

The results show that Focus training influences attitudes towards, and knowledge and skills for AOW in a positive way. This is in line with Branderhorst [38] who also found a positive effect of training activities on the attitudes of school staff towards school performance feedback. The fact that school leaders and internal coaches had a more positive general attitude towards AOW on the pre-test than teachers might have been caused by the fact that school leaders and internal coaches already knew more about AOW (which was proven in this study). As a result of this they might already have been more capable of seeing the importance of and need for AOW. Moreover, the more positive attitude of school leaders and internal coaches might also have been caused by the fact that they were involved in the process in which schools were asked to participate in Focus training, during which they heard more about the Focus training course and AOW, and its importance.

The growth in knowledge and skills for AOW varied considerably between the various types of school staff. School leaders and internal coaches scored better on the pre-test than teachers which might explain that they grew relatively little between the pre-test and the post-test. In other words, the Focus training activities professionalized teachers most with regard to how the student monitoring system could be used (the various types of analyses) and how the results of the analyses should be interpreted. As teachers were the central actors in the process of producing school results, this finding is very promising for improving the results of schools. One would expect that schools in which teachers learned how to use their student monitoring systems, and in which teachers used the information retrieved from their student monitoring systems for improving the quality of instructional processes in the long-run will have better results. However, choosing the most promising instructional strategies based on information regarding where the students are in the learning process is not easy [32].

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At the Heart of the Next Generation of Information Technology in Educational Management

Data Driven Discussion for Decision Making

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Abstract. Handling data in schools has moved from recording data in repositories, to reporting data to different stakeholders, to decision making using specific types of data. There are clear arguments that decision making functions require access to data, but the research literature indicates that discussion about points and issues is an important pre-requisite. This paper looks at evidence that highlights discussion as a fundamental need, offers two case study examples of schools integrating discussion that contributes to curriculum decision making with data, reviews a new data management system integrating features supporting discussion, and in conclusion highlights key points for future development.

Keywords: Data handling, data management, new data management systems, discussion making, decision making.

1 Introduction

Both data management systems and data handling processes in schools have changed over the past thirty years – starting with largely static systems allowing data to be recorded, moving through more widely accessible systems allowing data to be reported to different stakeholders, to access to data handling and analysis facilities enabling and supporting data driven decision making. A more detailed account of these shifts over time is discussed by Selwood and Drenoyianni [1] and Passey [2] in the context of data management systems in schools in England.

The term and concepts of data driven decision making (DDDM) are commonly associated with uses of data management facilities and applications when considering school needs. The term and concepts are often used in the context of schools and districts in the United States (US), where systems collect together distributed data through interoperability framework techniques, enabling different stakeholders to access and use these data through data mining techniques. A useful overview of research conducted across the US in terms of DDDM (Marsh, Pane and Hamilton [3]) states that: "DDDM in education refers to teachers, principals, and administrators systematically collecting and analyzing various types of data, including input, process, outcome and satisfaction data, to guide a range of decisions to help improve the success of students and schools." This report goes on to discuss ways in which

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 15–26, 2013.

different data can identify school strengths and weaknesses, and put interventions in place to support school improvement. Ways in which different forms of data are used in school improvement practices in a number of countries across Europe are also discussed in Visscher and Coe [4]). On a cautionary note, however, a report from the national inspection agency in England (Ofsted [5]) highlighted the need, when considering school performance and improvement, to understand the statistical background and validity when using different forms of primary and processed data.

Whilst uses of different forms of data supporting decision making are often clearly identified in advice and research literature, the roles of discussion in leading to appropriate thinking about and decision taking are explored far less. There is limited reference in the educational literature that explores this topic. It is not always clear, for example, how discussion is established when data is used to make decisions, or what processes are involved to account for influences of the data on critical thinking about curriculum concerns and issues. The fact that discussions happen is certainly not disputed. For example, Marsh, Pane and Hamilton [3] stated that: "In monthly calls with supervisors, these staff members rated schools and discussed strategies to address the problems in schools receiving the lowest ratings," Kirkup, Sizmur, Sturman and Lewis [6] stated that: "Schools reported that effective use of data resulted from meaningful dialogue between staff, and was supported by user-friendly systems," and the government department for education in England as a part of their early advice to schools (Department for Education and Skills [7]) stated that: "teams of teachers can learn from the good practice of each other, sharing strategies for dealing with individual students or analysing performance by using diagnostic marking. Discussions at planning meetings can produce action plans and targets for the team and individual students." Some educationalists have highlighted the critical importance of discussion in decision making; Treadaway [8] found issues arising in some schools where subject targets were given to students on the basis of data reports alone, without adequate discussion, and Hirokawa [9] found in a study outside the educational context that, for groups investigated, fulfilling critical task-achievement functions (or requisites) was a better predictor of decision-making performance than the discussion procedures employed in arriving at a decision.

The importance of data for informing discussion processes is not limited to stakeholders within schools. Advice from the government agency for e-strategy in England, Becta [10] stated that: "Research over the last decade has consistently shown that all children achieve more highly when their parents talk to them about their experience of school and learning. .... Technology can inform and enrich this engagement by enabling parents to receive and access information about their children's work, progress, attendance and behaviour when and where they want, using, for example, secure online or even mobile access." Byron [11], from a survey of 1,000 parents, confirmed the positive potential role of technologies, stating that: "Time-saving technology for online reporting, lesson-planning and homework (accessed by school websites and other online resources) make parents feel much more a part of their child's learning". But schools need not only to put in place systems that will provide levels of information and discussion between teachers, parents and learners, but also need to think about forms and nature of information to provide bases for useful dialogue, and

while in-school data systems are common in schools across England, fewer use systems to report online to parents. A national survey conducted by Infogroup/ORC International [12] stated that: "Technology was used for reporting to parents at least once a term in over three quarters of secondary schools (77 per cent), just over half of special schools (55 per cent) and less than a quarter of primary schools (23 per cent)." Basic online reporting to parents by primary schools is not yet common.

2 Methodology and Case Study Approaches

In this paper, issues concerned with relationships between discussion and decision making, and the ways that data management systems support these, are explored. To do this, two case studies are used to provide evidence of discussion processes involved when student data is used to inform curriculum and achievement processes. These case study schools were selected on the basis of being identified by independent school reviews and the data system providers as effective users of data management systems, and effective in terms of using these systems to support school improvement. From the case studies, key points where discussion is involved, the purposes of those discussions and the stakeholders involved are identified. In terms of potential future development, a new data management system that seeks to integrate discussion opportunities is reviewed in terms of the facilities it offers. How these match with the needs of the case study schools is highlighted, and future implications for development are subsequently considered.

The two schools, a mainstream secondary and a mainstream primary school, both located in the north of England, use data routinely and integrate its use with processes that involve discussion with different stakeholders. Evidence was gathered from these schools, and is reported in the form of case studies, using elements suggested by Yin [13]. In each case, the field work identified and detailed: the aims and objectives for using data in the school; the data management systems that were used; some background context to the school itself; the ways that data were used and how these related to processes of performance and improvement in the schools; what lessons the schools learned; and what issues arose. The field procedures involved discussions with key teachers and senior managers in the schools, and with some classroom teachers and heads of department. Background documents (national Ofsted inspection reports, not referenced to retain anonymity) provided an independent perspective on the overall achievements and performance of the schools. In discussions, key teachers and managers were asked open-ended questions, about their background contexts, aims and objectives for using data and data management systems, details of the data they used, what performance and improvement systems operated in the schools and how these involved the key stakeholders (managers, teachers, students and parents), what issues arose, and what they felt they had learned in terms of the outcomes, usefulness and future directions for the processes they had in place. The case study findings are presented in the next two sub-sections. Following these, there is an analysis of results (in terms of relevance and relationship to the issue of uses of discussion when data is used in performance and improvement processes in schools).

3 A Secondary School Case Study

This secondary school uses its data management system to track student performance. Its main intention is to support and maintain high standards of student progress, by providing timely information to the wide range of interested parties at certain times throughout the school year. This involves using integrated and appropriate tracking and monitoring systems from the time students join the school at 11 years of age. Ofsted (the independent inspection service that reports publicly on standards in schools) described the school as a place: "where standing still is not considered as an option. … Self-evaluation procedures are based on detailed analysis of information and resulting priorities and areas identified for further improvement are tackled resolutely. … The tenacious analysis by staff of pupil performance data ensures that work is well matched to their needs and interests. Senior leaders and middle managers are successfully held accountable for their pupils' performance."

The school, designated by the government department for education as a high performing specialist college in technology and applied learning, has some 1,100 students of mixed gender on roll, aged from 11 to 18 years. Teachers have online access to a school data management system in all classrooms and in all staff areas. A key member of staff initially ran an evening session for all staff, and a day session for pastoral staff on how to use the system. Use of the system by teachers is embedded within the wider school review system; a calendar of meetings is set up to discuss targets and progress, and to report to students and parents. Teaching staff maintain up-to-date records; they enter subject attainment assessments, behavioural and attitudinal grades and written comments on each student. Using the same data platform, they both view and analyse existing data. The system produces reports that go out to students and parents three times a year in paper-based form.

Two main sets of test data provide baseline information when students come into the school: national subject attainment test (SAT) results in mathematics, English and science; and commercial cognitive abilities tests (CATs). CATs are used to assess overall ability, and importantly, to identify significant differences from SAT results. Exploring reasons for differences often yield important information about an individual student that subsequently helps teachers to secure progress. A student may have used well-known test techniques to achieve well in SATs, but underlying cognitive abilities requiring on-hand non-revised skills may be somewhat weaker. The converse is also felt to be true; for a variety of reasons a student may not have made sufficient past progress, but have substantial potential that needs to be harnessed.

All subject teachers have access to background data sets no matter what their subject is (this is especially important as national SATs results are not available for subjects beyond mathematics, English, and science). Teachers access this information alongside their own subject specific data. Information in the data system is presented in columns, ordered by class groups and year groups. Further general details about students, those who gain special educational needs support, dates of birth, and gender are included. Teachers report specific details every term about learning skills, behaviour, organisational skills and completion of homework.

Based on background data, every student has clear targets in levels (up to 14 years of age) or grades (beyond this age), for each subject area. These are unique to the individual and derived from assessments of their starting points for learning at the beginning of each school year. When students are 14 years of age, all baseline data are reviewed and each subject department enters targets that are challenging, based on projected upper quartile levels taken from national data on past progression in individual subjects, an approach used for some years. Teachers have to offer strong evidence if they wish to set targets that are not recognised as a challenge. It is felt to be crucial that students are part of the target-setting process if they are to have ownership of the targets and work towards achieving them. Before finalising them, targets are discussed with each student and are agreed, rather than students being given the targets. Chances graphs from CAT tests are used to encourage high aspirations and teachers discuss with individual students the likelihood of success of achieving differing grades using agreed targets as measures. Actual attainments recorded by teachers are compared against targets at least once each term.

Tabular forms of presentation are the main forms used by teachers, and a traffic light system is used to indicate progress (indicators used by the school are 'Before' – lower than the starting point, 'Static' – still at the same level as the starting point, 'Towards' – moving towards the target, and 'Met' – the target is achieved or exceeded). Traffic lights allow colours to be selected, and columns can be ordered so that groups within classes or year groups can be identified. Graphical representations are also used to display average point scores by class and year group, to look at quartile ranges, and progress each half-term across a period of 3 to 5 years. Changes from year to year, and trends over time are reviewed every year with the leaders of each curriculum area and senior management.

The school finds that using baseline data, agreeing targets, and monitoring progress status (above or below the target) allows a case study approach with individual students, maintains tracking, picks up any issues regularly, and allows ways to address issues to be identified. The school recognises that having a system in place means that it is necessary to act on what is found; otherwise it is felt it would not be worthwhile. It is also recognised that ownership at this level can create stress, since clear statements are being made about expectations. Teachers can recognise progress or lack of it; curriculum leaders can identify whether lack of progress may be due to student, course, or teacher. They examine progress closely three times a year, looking for dips and reasons for those dips. They pick up on topics that need to be rechecked or revisited, if performance is low. Teachers can identify variations in progress across specific groups of students (for example girls or boys, or vulnerable students).

The use of progress grades ('before', 'static', 'towards', 'met') is recognised as a powerful way to identify real issues and ensure that all students are focussed on future aims. Students and parents understand the level and grade systems, but using progress grades means that value is placed on effort, hard work and diligence. All are felt to make progress according to their ability and this is celebrated at every opportunity.

The system in place means that information for teachers is available readily and quickly, so that teachers can see progress levels and grades across all subjects. Although teachers now find the system easy to use, and find it beneficial overall, they

also feel it places some quite heavy demands upon them. It was necessary for the school to invest time and support effort initially to ensure that teachers knew what to do when things went wrong, and how to appropriately level subject attainment so that there was parity across a department, consistent with national norms. After some years it is felt that all staff approach testing, assessment and monitoring similarly, offering a cohesive approach across the school.

4 A Primary School Case Study

The primary school had used a management information system for over 10 years, to help manage student attendance, behaviour and performance. The school sought to ensure highest possible performance for its students, looking for positive ways to maintain a consistently supportive learning environment. Keeping track of student data supported staff using systems that aimed to address any 'student disengagement' (movement away from positive behaviour, attendance and achievement). The system informed about current and historic 'drifts', but then allowed the impact of behaviour interventions to be seen through on-going data collection.

The data management system was supported by the local authority. The school benefited also from another local authority system, which collated attainment and other data, such as behaviour data, entered by teachers through a web interface.

The school had some 420 students of mixed gender on roll, aged from 4 to 11 years. There were a high number of students with special educational needs (in the order of 170), but many were gifted and talented (in the order of 50). Behavioural issues did arise; four specialist staff picked up these issues, and used an on-site unit that provided a supportive environment. It was found that the system was easy to use, and was used by all staff. Limited training was found to be effective. Time to develop practice was found to be relatively low; about an hour and a half to develop use of the attendance elements in the system, for example, while no training was needed on a new register facility. Staff found it easy to access information, and they could use the information provided. All teaching and support staff used laptops for entering registration, behaviour and achievement data (appropriate to different staff roles).

Three main sets of data provided on-going information: student attendance, recorded by teachers at the beginning of each day, by 9.05 a.m., to be viewed by the head teacher; issues with behaviour, recorded by all staff as they arose; and teacher assessments, recorded at intervals across the year. Both the head teacher and deputy head teacher tracked attendance and behaviour, to pick up on any issues very quickly. They found that this was particularly important for a highly mobile student population. At the same time, they found that the management system provided all teachers with a very rapid overview, a 'big picture' showing a summary of behaviour, attendance and achievement, which supported informed discussion and decision-making. They found that this could lead to improved teaching, as information at this level could enhance and empower support staff as well as teaching staff.

Different key teachers acted on different aspects of information provided: all teaching and support staff had access to the three basic data sets, which were presented in

tabular form; the head teacher acted on attendance information; team leaders acted on behaviour, attendance and achievement information; and the head teacher used trend data to consider future strategy and actions. The head teacher accessed trends over a 3-year period, and could see graphically what had happened in terms of behaviour, attendance and achievement. He used the system to calculate and measure progress on the basis of combined scores in mathematics and English, and identified target groups for curriculum support from these results.

In order to use teacher assessments in these subjects, and to know that they could be used reliably, the school had to do a great deal of in-service discussion and moderation, looking at how to level assessments on students' work. The head teacher found that the system was flexible enough to allow the recording and reviewing of data associated with particular curriculum interventions, such as 'Big Writing'. Subject co-ordinators found tracking grids (grids showing a progression of results over time in tabular form) were very useful, for monitoring what was happening across their subject areas. Subject targets for specific students in subject areas were entered into the local authority data system.

The system was used to produce reports that went out to parents in paper-based form. Reports for parents were generated using the management information system; teachers put in their comments first, then they had access to comment banks where they could choose additional comments to include in reports. The head teacher and deputy head teacher proofread reports before they went out to parents.

The school found that the system and the data allowed team leaders to engage more readily with parents, class teachers, teaching assistants and behaviour improvement specialists. The school would have liked to have developed closer use of the system by students, however; encouraging students to discuss targets would have been an avenue felt to be worthwhile.

It was found that the management information system provided important avenues of communication. Bulletins and reminders were used by the special educational needs co-ordinator, reminders of meetings were sent out, and all staff had access outside and inside school for adding data to the system and for writing reports. The head teacher found that access at home often allowed undisturbed time to be given to reviewing data. It was found that having behaviour data on the system allowed discussion about the facts in an objective way; the school had no student exclusions, whilst previously there were up to 4 each year.

The head teacher felt that the system was flexible enough to support different approaches to the curriculum. At the time details were gathered, the curriculum in the school was totally topic-based, and there were five topics run across a year in each class. A portfolio of student work was collected at the end of each topic, and these portfolios demonstrated the creative and practical achievements of students, as well as their subject achievements. The curriculum had a practical, creative and visual focus. This form of curriculum (not the same as the subject-based approach adopted in many schools in England) was nevertheless supported by the management information system. Assessments of creative, practical, social and emotional outcomes, for example, could be entered readily within the system.

5 Key Points Arising

It is clear from both of these case studies that discussion plays crucial parts at certain points in the curriculum review processes using data to support school and curriculum needs. The crucial points where discussions were involved are shown in Table 1.

Table 1. Crucial discussion points arising in the two case studies

Discussion point	Secondary school case	Primary school case
Knowing about the data system	Teachers are shown the system and can ask questions about it	Teachers are shown the system and can ask questions about it
Levelling subject attainment	Teachers meet with curriculum leaders to discuss and agree levelling of subject atainment to ensure parity	Teachers meet with senior leaders to discuss and agree levelling of subject atainment to ensure parity
Setting targets for students	Teachers discuss targets with individual students in meetings across the year, focusing on chances of gaining different potential grades	-
Monitoring student progress	Teachers discuss any issues about progress at least three times a year with students	Teachers discuss any issues about behaviour, attendance or achievement with students as these arise
Considering curriculum content	-	Teachers and support staff review behaviour, attendance and achievement results to consider appropriate curriculum content
Monitoring course progress	Curriculum leaders discuss with course teachers any issues about progress at least three times a year	Senior leaders discuss attendance and behaviour issues with teachers as these arise
Reporting to parents and students	Teachers report to parents and students in face-to-face meetings across the year, referring to attainment results, learning skills, behaviour, organisational skills, completion of homework and regular written comments	Team leaders, senior leaders and teachers talk to parents about achievement, behaviour and attendance
Reviewing trends and changes over time	Teachers discuss changes and trends once a year with curriculum leaders and senior managers	-

The discussion points can involve a number of different stakeholders, which might be: teachers and senior managers in schools; teachers and students; teachers and parents; and teachers or school managers and inspectors or advisors. The involvement of stakeholders in different discussion points is shown in Table 2.

Table 2. Stakeholders involved in key discussion points

Discussion point	Secondary school case	Primary school case
Knowing about the data system	Senior managers, subject leaders and teachers	Senior managers, team leaders, teachers and support staff
Levelling subject attainment	Senior managers, subject leaders and teachers	Senior managers, team leaders and teachers
Setting targets for students	Senior managers, subject leaders, teachers and students	-
Monitoring student progress	Teachers, students, subject leaders and senior managers	Team leaders, teachers, support staff, students, and parents
Considering curriculum content	-	Team leaders, teachers and support staff
Monitoring course progress	Senior managers, subjects leaders and teachers	Senior leaders and teachers
Reporting to parents and students	Senior managers, subject leaders and teachers	Team leaders, senior leaders, teachers and parents
Reviewing trends and changes over time	Senior managers and subject leaders	-

Different schools are likely to use curriculum review processes that will occur at different times across the school year, and also different stakeholders depending on specific school contexts and needs. The discussions involved, which could be concerned with making decisions to intervene or set targets, for example, are likely to be crucially important. So, maintaining records of the discussions themselves, and the backgrounds to decisions, could be just as vital as maintaining a record of the background or underlying data themselves. How does a data management system provide for this type of need, and how does its functionality fit with the overall process of school monitoring and improvement practices?

6 Features of a New Data Management System

In the past, records of discussions, whether between teachers, or a teacher and senior teachers, or a parent and a teacher, or a student and a teacher, have been likely to be kept in a separate register or document store. The facilities now available within software that create data management systems can provide for levels of such record

keeping, at times that individuals can choose far more, rather than only needing to rely on times determined for specified meetings.

The specialist company Different Class has created a new data management system, called DCPro, which provides features to support both synchronous and asynchronous communication and discussion between stakeholders. In this system, when a teacher or school manager either enters a data record or views a record, then they can include a comment to accompany that record. A box appears when the cursor is placed over a cell containing data, allowing the user to enter a comment, as well as enabling supporting documents to be added. The DCPro system further allows the user to identify those stakeholders who should see or have access to those comments. When other users access the system, they are alerted to the fact that comments or attachments are added, and they can then also add their own comments or documents to continue further discussion, should they feel that that is required.

In terms of the facilities that this system offers, and comparing these to the discussion needs of the two case study schools, in the context of the secondary school: initial discussions following a presentation of how the system could be used (involving senior managers, subject leaders and teachers) could be continued and followed up, although this would probably require a copy of the data set to be accessible for this specific purpose, to separate this activity from review process activities; discussion about reasons why different tests indicate different potential abilities (involving senior managers, subject leaders and teachers) could certainly be taken up by teachers commenting on individual student results; discussions across the year about targets (involving senior managers, subject leaders, teachers and students) could be taken up, but the facilities in the system do not currently allow the crucial element of student involvement; discussion across the year about progress (involving teachers, students, subject leaders and senior managers) could be taken up, but again the facilities do not enable student engagement in this discussion; discussions about reporting to students and parents (involving senior managers, subject leaders and teachers) could be undertaken, but it is not clear that details of agreed elements in reports would be held separately in the system to allow separate and restricted dialogue; and discussion annually about trends over time and any changes that are identified (involving senior managers and subject leaders) could be taken up with the system as it stands. In the context of the primary school: discussions about behaviour and attendance (involving senior managers, teachers, support staff, students, and perhaps parents) could be taken up, but there is no facility currently to enable student and parent involvement; discussion about trends over time and any changes that are identified (involving senior managers and team leaders) could be taken up readily; discussions about achievement (involving team leaders, teachers, teaching assistants, students, and parents) could be taken up, but facilities do not enable engagement of students and parents currently; discussions about the levelling of teacher assessments (involving senior managers, team leaders and teachers) could be taken up using the facilities; and discussions about subject attainment (involving subject co-ordinators and teachers) could also be taken up readily.

7 Conclusions

As Milkman, Chugh and Bazerman [14] said in their review of improving effective decision-making: "People put great trust in their intuition. The past 50 years of decision-making research challenges that trust." These authors argue that there is a need to move from intuitive decision-making processes to overcome decision biases, "replacing intuition with formal analytic processes. For example, when data exists on past inputs to and outcomes from a particular decision-making process, decision makers can construct a linear model, or a formula that weights and sums the relevant predictor variables to reach a quantitative forecast about the outcome." Research exploring uses of data management systems in schools indicates that discussion to understand what data are describing is an important part of the process, and that in some cases reduced discussion can lead to demotivation of students, which in turn is likely to lead to reduced rather than improved outcomes (Treadaway [8]).

8 Future Needs for Data Management Systems

Undoubtedly data management systems that provide for forms of discussion are already able to support fundamental needs for involvement and interactivity required at certain stages of the monitoring and decision making processes. The fact that individuals with a variety of roles across a school can now do this remotely, and can continue a discussion asynchronously to meet their time needs as well as those of others has been highlighted already as positively supporting school and stakeholder needs. A key element that has been highlighted, however, is that discussions involving two crucial groups of stakeholders, parents and students, are not yet integral to the system explored in this study. The data management system examined in this study now provides for discussions for school teaching and support personnel. The development of facilities for discussion by students and parents is perhaps a next step. Indeed it can be argued that a discussion without students and parents will have limitations (and that the level of limitation could be determined by and could be directly related to the level of discussion that happens). However, it could also be argued that an online discussion medium is not ideal for these purposes.

What is needed next is to assess the discussion needs of school performance and improvement practices much more widely, to ensure that the different elements of discussion that are involved, by different stakeholders at different times, are able to be met through continued technical developments of systems themselves. From the analyses of the case study schools, additional features identified at this time are: for profesional development purposes, a copy of the data set to allow discussions following a presentation of how the system could be used; for discussions across the year about targets, features to involve students; for discussion across the year about progress, facilities to enable student engagement; for discussions about reporting to students and parents, facilities that hold separate report details for parent and student engagement; and for discussions about behaviour and attendance, facilities to enable student and parent involvement.

Technologies now allow audio and video to be readily captured, added as files, and accessed by others. Although text comments can be useful, audio or video files could enhance certain practices. This aspect of development has not been taken forward at this time, but clearly its potential is worthy of further exploration. Digital technologies now offer the potential to enable discussion to be built into data management and handling processes. The fundamental positions of discussion within important performance and improvement practices need to be identified and accommodated in future systems that serve the needs of all stakeholders.

Acknowledgements. The author thanks most sincerely the head teachers and teachers providing evidence in the case study schools, and Dr Paddy Guest and Mark Bedwell, the directors of Different Class, for providing background material.

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The Use of Data across Countries: Development and Application of a Data Use Framework

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Abstract. Promising evidence exists that data-based decision-making can result in improvements in student achievement [1], but studies, e.g. [2], show that many schools do not use data properly. Support in the use of data is urgently needed. This chapter focuses on the design of a professional development course in the use of data. In the first phase of the project, case studies were conducted in five participating countries (England, Germany, The Netherlands, Poland and Lithuania) to develop a common data use framework. In the next phase, in two schools in each of the countries, a data use needs assessment was conducted using a survey. Finally, a professional development course was developed and implemented. Results of each of the phases are discussed in this paper.

Keywords: Data-based decision making, school improvement, professional development.

1 Introduction and Theoretical Framework

Schools internationally are held more and more accountable for the education they provide. This requires them to use data as a basis for their decisions. Promising evidence exists that data-based decision-making can result in improvements in student achievement [1], but studies [e.g. 3] show that many schools do not use data properly. Support in the use of data is urgently needed. This paper focuses on the design of a professional development course in the use of data. The project described here consisted of five phases: case studies; survey administration; course development; course implementation; and course evaluation. This paper focuses mainly on phases 1 to 3.

Firstly, case studies were conducted to answer the following research questions:

1. For which purposes do school leaders and teachers use data?
2. Which factors influence the use of data?

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 27–38, 2013.

The main objective of this phase of the project was to come up with a common data use framework. Since a generally accepted "data use framework" is missing, we developed our own framework based on our literature review, as well as interviews with schools in five European Union (EU) countries and the analysis of policy documents (for an overview of the literature used see [4]). Versions of this framework were published in [3] and [2].

The theoretical framework hypothesizes that several variables with regard to organizational, data and user characteristics influence the use of data. The policy context (such as pressure for achievement) also influences data use within schools. Teachers and school leaders can use data, such as assessment and survey data, for different purposes: for instructional purposes; for supporting conversations with parents, students, fellow teachers, and fellow administrators; for shaping professional development; for encouraging self-directed learning by giving the data to students; for policy development and planning; for meeting accountability demands or complying with regulations; for legitimizing existing or enacted programs; for motivating students and staff; and for decisions related to personnel (e.g. evaluating team performance and determining and refining topics for professional development).

The use of data may lead to an effect on teacher, school leader, and student learning. Teacher and school leader learning is defined in this study as changes in attitude (e.g. towards data use), knowledge (e.g. pedagogic knowledge) and behavior (instructional or leadership strategies) [5]. For example, a teacher who is not satisfied with certain assessment results may decide to analyze the test results more critically. Based on these data he may come to the conclusion that he should make changes in his instruction. As a result, he may start using different instructional strategies (teacher learning: behavior). Data on the next test results can tell him whether or not his changes were successful in terms of whether they led to higher student achievement results (student learning) [6]. However, data use may also have unintended effects, such as stress and de-motivation among school staff as data may give the (surface) impression that they are performing poorly in some aspect of their practice.

2 Method

In the five countries participating in this project (England, Germany, The Netherlands, Poland and Lithuania) case studies were conducted. For the case studies, interviews were held with teachers and (assistant) school leaders. We interviewed respondents with regard to which purposes school leaders and teachers use data, and which variables promote and hinder the use of data. In each country at least two schools were included in the interviews. In Germany, 6 teachers and 6 assistant school leaders of two schools were interviewed. In the Netherlands, 11 teachers and 21 assistant school leaders of six schools were interviewed. In Lithuania, 15 assistant school leaders of two schools were interviewed. In Poland, 11 teachers and 2 assistant school leaders of two schools were interviewed. In England, 6 teachers and 8 assistant school leaders

of four schools were interviewed. Documents (e.g. policy plans, literature, and Organisation for Economic Development (OECD) reports) were collected to describe the educational policy (related to data use) in each of the countries.

Based on the data use framework that was developed from the case studies, we conducted a survey study to diagnose data use practices within two schools in each of the countries (e.g. the partner schools) and their current capacity to use data effectively. Participants were asked to rate 78 data use-related items [4] by their accuracy or frequency. The survey was administered prior to and after the data use course. In 2011, 398 teachers from 10 schools in 5 countries completed the survey. In 2012, 228 responses from 7 schools in 4 countries were collected.

The collected data were analyzed in two ways. Firstly, school reports with diagrams, means and standard deviation values for every survey item were created to give feedback to the pilot schools. Secondly, the data were analyzed in a cross-country exploratory factor analysis by specification search [7] to determine which areas of data use influence one another. The factors derived from the survey items were: (1) data accessibility, (2) data quality, (3) user attitudes, (4) user skills, (5) school leadership, (6) school cooperation, (7) school vision and norms, (8) school training and support, (9) using data for accountability, (10) using data for school development, and (11) using data for instructional development.

The results of the case studies and data use survey, combined with an analysis of existing data use courses [6, 8, 9], informed the development of a data use professional development course which was designed to address the documented lack of capacity of school leaders and staff to effectively use data to improve student outcomes. The goals for the course were developed within a 5-stage data inquiry model that served as an inquiry framework to support participants as they learned how to use data for problem solving and decision-making in their schools. Eleven professional development modules were developed to meet the goals within each phase of the data inquiry model.

3 Results - Case Studies

3.1 Policy Contexts

Five different countries participated in the project with different policy contexts. *Germany* has 16 different states, and each state is responsible for providing education. Within the states, schools are centrally organized, and very limited autonomy exists for schools [10, 11]. Germany has a standard curriculum or partly standardized curriculum that is required, as well as mandatory national examinations and assessments [11]. Internal evaluations are not compulsory, but school boards and other organizations offer tools and support. Types of data that are available differ by state: all have student achievement results; some have inspection and self-evaluation results. Little to no support exists for schools in the use of data.

England works with published national data sets (League tables). Schools in England have a significant amount of autonomy [10, 11]. England does have a standard

curriculum, mandatory national assessments are required in state schools, but national examinations are optional but rarely not taken [11]. Schools are inspected by Ofsted, who provide schools with inspection reports. Internal evaluations, using lesson observation, perception questionnaires, attainment and achievement data, are highly recommended. External inspections from external evaluation agencies are optional. There is an expectation that teachers will undertake continuous professional development activities and approximately 5 teaching days (out of 195) are allocated to this activity. Also, England has a national student database, and achievement and attainment tables, which makes important information available in a systematic and largely accessible manner.

In *Lithuania*, schools are evaluated both externally and internally. External evaluations are carried out by the National Agency for School Assessment. Internal evaluations are required as well. Schools can use the internal audit methodology developed by the National Agency for Internal Evaluation or use their own system. Internal evaluations are carried out by the school administration in cooperation with teachers.

An important legislative act for *Polish* education is the Pedagogical Supervision Act, passed in 2009. The act states that all schools in Poland must be externally evaluated by education authorities. The Ministry of National Education provides curriculum standards, districts and municipalities control administration and financing. School directors have autonomy as far as the decision making around hiring teachers, approving programs and textbooks, conducting internal evaluations. Poland has mandatory national examinations and assessments. A lot of data are available; however these are mostly (value added) achievement data. Schools have electronic data systems in place.

In the *Netherlands*, schools have significant autonomy. Similar to England, almost all decisions are made at the level of the school [10, 11]. The Netherlands does not have a standard curriculum or partially standard curriculum that is required; it does have mandatory national examinations, but no national assessments [11]. However, schools are held accountable for their functioning by the Dutch Inspectorate. As schools are responsible for the quality of education they provide, they have to conduct a school self-evaluation to check their quality and improve if necessary. Different consultancy organizations offer data use trainings, but participation is up to schools.

3.2 Data Available and Data Use

The results of the case studies show that in both *German* schools a lot of data are collected, but are not systematically used. School leaders mainly use data for administrative purposes. Teachers use data to monitor progress of students and to determine the need for individual student support or instructional changes. Probably partly due to the *English* context, a wide range of different types of data are used for different purposes by the four schools included in this study, ranging from accountability purposes to school improvement purposes. The results of the interviews in the two *Lithuanian* schools show that schools would like to use data more extensively than they do, currently mostly using different types of data for monitoring purposes. Data are used for a wide range of purposes in *Poland*, including monitoring purposes and

improvement purposes, but this only happened in small pockets. The results of the interviews in six *Dutch* schools show that, although a wide range of input, process and output data are available, the use of data is rather limited. Only in two of the schools were data really being used by teachers and school leaders for school improvement purposes (for more detailed results see [4]).

3.3 Influencing Factors

Firstly, *data and data system characteristics* can influence the use of data. In Germany, Lithuania, and the Netherlands access and availability of data were found to be a problem sometimes. Especially in Germany, respondents indicated that this was a problem in their schools. One of the respondents stated "schools have only limited access to data and no real autonomy". Often data are not fed back (e.g. availability) to the schools and the decisions based on these data are not transparent. Moreover, the data collection for the national learning performance measurements is carried out within the school and is very error-prone, resulting in low quality data. Some respondents of the UK, Lithuania and the Netherlands also indicated that there were problems with the quality of the data in terms of, for example, accuracy, but especially with regard to timeliness. Lithuanian respondents indicated that external and internal evaluation did result in usable, relevant, reliable and accurate data. Respondents in Poland all indicated that the data available were perceived as reliable, valid, and accurate. England has the most sophisticated data systems and data tools available. For example, English schools have access to a national student database, and achievement and attainment tables, which makes a lot of needed information available in a systematic and largely accessible manner. Overall schools have access to data systems, a wide range of data and also have tools available to analyze and use data. In contrast, in Germany a problem existed with regard to interoperability between the different data sets. Hence, the relation between different data could not be analyzed. Moreover, problems existed with regard to the ICT infrastructure. Finally, respondents in the Netherlands complained that there was too much data out there and that "data are not always accessible, partly because there are too much data available".

Secondly, *organizational characteristics* can influence data use. A lack of time and money was found to impede data use in schools. Several respondents complained about a lack of time to use data (Germany, UK, The Netherlands). Collaboration was found to be an important promoting factor of data use. Collaboration around the use of data was not common practice in Germany. Teachers in England, Lithuania, Poland and the Netherlands did collaborate around the use of data (to some extent). For example, in Poland, in one of the schools, teachers collaborated usually in subject specific team meetings, where student outcome data was analyzed, sometimes at the request of the school leader. The school leader coordinated and supported the work of the teams in one of the schools. A lack of training can impede effective data use. In England, different types of training as well as data tools were available. Lithuanian, Dutch and Polish respondents indicated needing training in the use of data. Also, the availability of a data expert, as was found in England and the Netherlands, can promote data use. Lithuanian respondents indicated a need for a data expert. Having a

clear vision, norms and measurable goals can promote data use. English and Dutch respondents mentioned that the school had established a clear vision with regard to data use and clear and measurable goals. Lithuanian respondents also mentioned this, as well as using data to monitor the implementation of this vision and these goals.

Finally, *user characteristics* can either promote or hinder data use. In Germany and Lithuania, respondents indicated a lack of data analyses and data use skills. In England, some teachers indicated having the necessary knowledge and skills; others indicated they needed further professional development. Respondents in both Polish schools believed in the use of data. Moreover, in one school, teachers had the knowledge and skills needed to work with data, as these teachers were certified examiners. In the other school, teachers indicated lacking the skills to use value added data. Moreover, in the Netherlands, school leader support and a belief in the use of data were found to be important. An external locus of control present in two of the schools may have hindered data use as these teachers stated that "assessment results are different each year, depending on whether you have good or not so good students" (for more detailed results see [4]).

Based on the results described above, we developed the data use framework displayed in Figure 1. In this framework, policy influences the enablers and barriers to data use, data-driven decision making, and stakeholder and student learning. Different aspects of a country's policy may be of influence. Firstly, characteristics of the *accountability system* may play an important role. For example, the presence of an inspectorate (such as in England and in the Netherlands) and other forms of *external evaluation* (such as in Poland, Lithuania) may influence data use. Schools may perceive these evaluations as a form of *pressure.* Another form of pressure that is put on schools is the *public presentation of school performance*, such as in England (in League tables), in the Netherlands (online and in rankings that appear in newspapers and journals) and Lithuania (online). Moreover, schools in some countries, such as Lithuania, the Netherlands and England, are expected to engage in *school self-evaluations*, leading to additional data schools can use. Also, the amount of *autonomy* schools have in decision making can affect data use. In England and the Netherlands, schools have a lot of *autonomy*, and they can make almost all decisions (with regard to the curriculum, instruction, personnel and resources) themselves. In Germany, schools have a lot less autonomy. Furthermore, a policy context influences *the types of data* that are available. Some countries work with national standardized assessments (Germany and Poland) and/or national standardized examinations (Germany, Poland and the Netherlands). Finally, if a country offers training (and sometimes a reduction in teaching hours as a consequence of taking the training) this can influence the extent to which school staff are able to engage in effective data use.

As displayed in Figure 1, different enablers and barriers influence data-driven decision making. Firstly, characteristics of the organization influence data-driven decision making. The following organization variables were found to influence data-driven decision making in the different countries (e.g. in some countries the lack of these variables hindered effective data-driven decision making, while the presence of these variables promotes effective data-driven decision making):

- Structured time is set aside to use data and structured processes for data use exist within the school (G, N, L, E, P) (Note: G, N, L, E, P refer respectively to German, Netherlands, Lithuanian, English and Polish schools).
- The availability of an data expert who can provide the needed data in a timely matter, as well as assist in analyzing, interpreting, and using data (G, N, L, E).
- The availability of training: professional development in accessing, analyzing, interpreting and using data (G, N, L, E).
- Teacher collaboration: teachers collaborate around the analysis, interpretation and use of data, in for example subject matter teams, grade level teams or data teams (G, N, L, P, E).
- Vision, norms and goals for data use: the school has clear goals and visions, and data can be used to monitor the extent to which the school is reaching these as well as to come up with measures to improve, if necessary. Moreover, the school also expects school staff to use data on a regular basis and specific norms and goals with regard to data use exists (G, N, L, E).
- The school leader actively supports, encourages and facilitates data use (for example, by structuring time) (N, P).

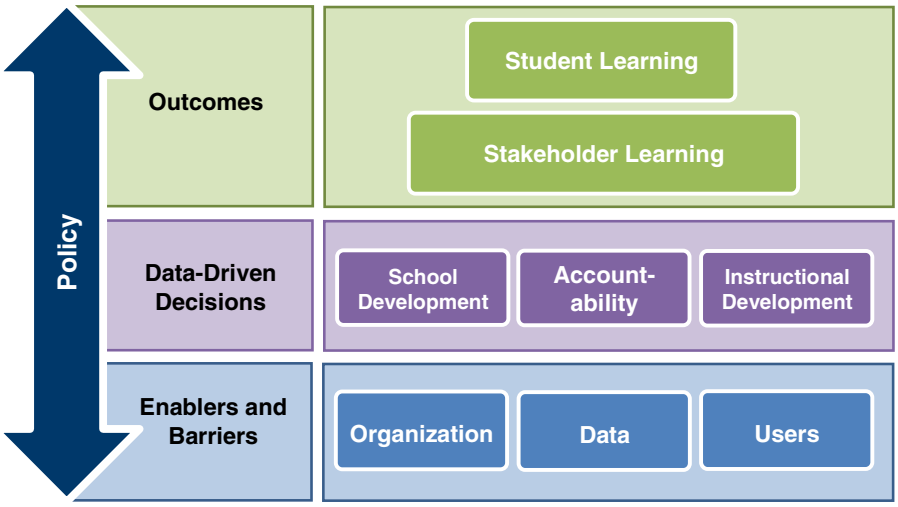

Fig. 1. A data use framework

Secondly, characteristics of the data influence use. Specifically, the following variables were found to play a role:

- Accessibility and availability of data and information logistics, for example through information management and other data systems. School staff should be able to find the data they need easily and timely. Data should be aligned, and school staff should not have to look into three different systems to obtain the types of data they need (G, N, L, P, E).
- The quality of data: schools need timely, accurate, valid, relevant, reliable data, which coincides with their needs (G, N, L, P, E).

- Tools, which support data analyses, interpretation and use (e.g. which can aggregate data, can calculate attainment and progress, adjusted to socio-economic status etc.) (G, N, E).

Thirdly, user characteristics influence data use. The following variables were found to play a role in the different countries:

- Attitude toward data: It is important that school staff believe in the use of data, that they think it is necessary to use data to improve their practice, and that they are motivated to use data (G, N, L, P, E).
- School staff need knowledge and skills to collect, analyze, interpret and use data (G, N, L, P, E).

The different enablers (if these variables are present) and barriers (absence of these variables) influence the extent to which data are used to base decisions on. We distinguish between three different types of data-driven decision making (although these sometimes overlap). Firstly, the use of data can be used for school development purposes. In the case studies described above the following school development purposes were mentioned:

- Policy development and school improvement planning based on areas of need and strong aspects (N, E, G, L, P).
- Teacher development (G, N, L, P, E).
- Grouping of students and placing students at school level (G, P, E).
- Monitoring the implementation of the school's goals and, if necessary, (re)defining aims and objectives/setting new targets (L, E).
- Motivating staff (E).

Data can also be used for accountability purposes. The following accountability purposes were identified in the case studies:

- Public relations, to show the outside world how good the school is doing (G, N).
- Communication with parents (e.g. schools are accountable to parents) (G, L, P, E).
- Communication with other schools (L).
- To meet accountability demands (for example, self-evaluation results are used as a basis in external evaluations) (N, E, P).

Thirdly, data can be used for instructional development, such as:

- Monitoring progress of students (G, N, L, P, E).
- Adjusting instruction (e.g. adapting instruction towards the needs of students, grouping students differently, determining the content of instruction, giving students feedback, providing students with additional time etc.) (G, N, P, E).
- Curriculum development (P, E).
- Motivating and rewarding students (E).

If data are used for these different purposes, this may lead to stakeholder (e.g. teachers, school leaders, parents) learning. For example, a teacher might decide to make instructional changes based on data (data-driven decision). This leads to improved instruction by the teacher (outcome: teacher stakeholder learning). Stakeholder learning in turn may lead to student learning (e.g. inquiry of students into their own learning and improved student achievement).

4 Results Survey

Based on the data use framework described above, a data use survey was developed and administered to ten schools in the five countries. The cross-country survey analysis shows that the intention of the Comenius project is targeting an area that is both valued as of high importance by the survey respondents and at the same time significantly underdeveloped. More than 50 per cent of the respondents (strongly) agreed that "it is important to use data to diagnose individual student learning needs" and that "data can offer information about students that was not already known". Moreover, more than half of the respondents stated that their "principal or assistant principal(s) encourage data use as a way to support effective teaching". And finally, the cooperation level seems also promising: Most "would like to collaborate more with other educators about using data", their school "effectively communicates school improvement goals" to them, and the respondents "share and discuss student performance data with students, parents and other teachers".

A correlation analysis further showed that all factors derived from the survey items influence each other. The factor analysis revealed which of them describe the current status of data use. The structural equation models in Figure 2 visualize these results for the cross-country sample in 2011 and 2012.

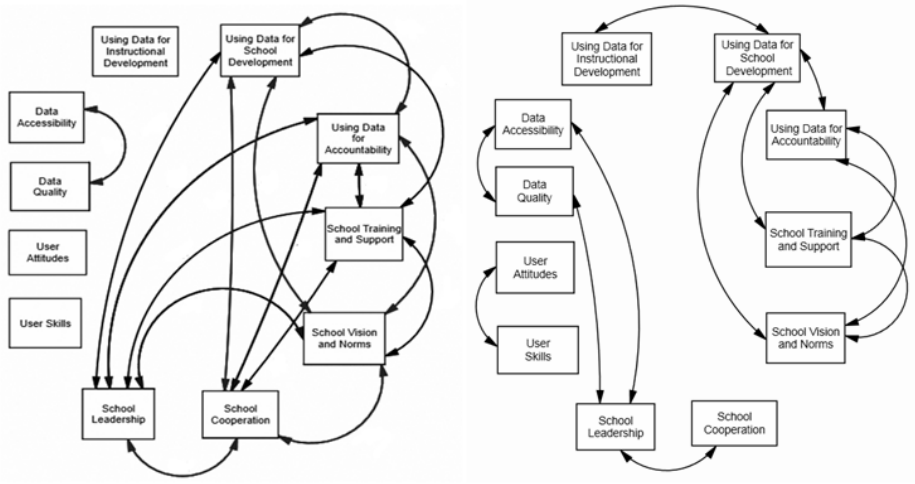

Fig. 2. Cross-country models with correlations between factors 2011 (left) and 2012 (right)

A look at the 2011 model revealed important insights for the further development of the project. Certain factors are linked to others very often and others are not linked at all. *School Leadership*, for example, is linked to five other factors. Also, most of these five are interlinked. This means that these factors have the highest influence on each other and thus on aspects of data use in all countries. This reflects the results of nearly all empirical studies on school improvement in which the role of the school leader is regarded as a necessary condition for change [12, 13]. The factors that are

not linked at all in the 2011 model are *User Skills*, *User Attitudes* and *Using Data for Instructional Development,* which are the key elements in the goals of the Comenius project. At this stage, the skills and mind-set of EU teachers in this cross-country sample to use data for instructional development are significantly underdeveloped. In 2012, this changed. *Using Data for Instructional Development* plays a more active role and *User Attitudes* and *Skills* change together. Also, *School Leadership* is now connected to factors outside the school realm and has important correlations with *Data Accessibility* and *Quality*.

5 Characteristics of the Data Use Course

The results of case studies and survey, combined with the analysis of existing data use courses, informed the development of the curriculum and the content of the data use course described in this paper. It consists of 11 obligatory modules which are organized according to the 5 stages of a data inquiry model: preparation; discovery; diagnosis; doing, and evaluation (see Figure 3). The course was designed to guide teams of teachers and school leaders (professional learning communities (PLCs)) through a structured and iterative application of the 5-stage inquiry model, relying heavily on data analysis and collaboration protocols, templates and tools, and authentic learning activities to build the necessary technical, analytical, and collaboration skills.

Modules 1 and 2 (*Getting Started and Data Literacy*) are Preparation modules that build the capacity of the PLC to work collaboratively with data. Modules 3 to 11 guide the PLC through each stage of the data-driven inquiry model: Discovery (*Identifying a Problem, Evaluating and Analyzing Data*); Diagnosis (*Hypothesizing and Analyzing Root Causes*); Doing (*Brainstorming Initiatives, Developing Action Plans and Monitoring Implementation*); and Evaluation in which they reflect upon the initiatives they implemented throughout the course. The course helps build the capacity of the school-based teams to not only engage in their own inquiry, but to serve as catalysts for whole-school data-driven decision making (for more information on the data use course see: www.datauseproject.eu).

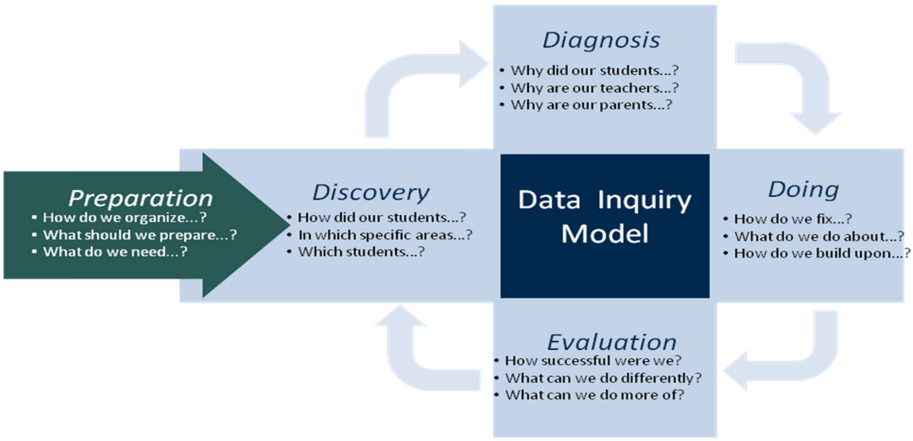

Fig. 3. The Data-Driven Inquiry Model

6 Conclusion and Discussion

Before coming to conclusions, we have to discuss the limitations of this study. First of all, the schools that participated are no means a representative sample. We want to emphasize here that the goal of this part of the project was not to make firm generalizations, but to gain more insights into the use of data in different schools. The data were collected by interviewing teachers and school leaders and by administering surveys in only a few schools per country. Teachers' and school leaders' self-perceptions were used to study their use of data. We used triangulation (e.g. interviews, documents and surveys) and we checked the comments made by the respondents by asking for more details and by asking for examples. Still, the data may produce a slightly colored or biased picture of the actual use of data within schools. Lastly, we conducted some of our analyses across countries and based on combined school leader and teacher data. This might have led to the loss of certain nuances, and of course we do acknowledge that there are differences between the use of data by school leaders and teachers [see 3] and between the use of data between but also within countries and within schools. However, as the results are in line with the results of several other data use studies, we do feel confident that the results of this study present an accurate picture of the current use of data in schools in different countries.

Based on the case studies, a data use framework was developed, which informed the development of the data use survey. The survey analysis was an important first step in the process of establishing a school-wide culture of data use. It captured the schools' areas of strengths as well as areas for improvement under key data use categories. According to the survey results, schools in Poland, Lithuania and England took the lead in the practice of data use while the schools from The Netherlands and Germany show lower levels of activities in many areas. However, respondents in all countries indicted a need for (further) provision of training and support in the use of data, which the data use course we developed tried to provide.

All ten schools in the five participating countries implemented the data use course and followed it for a period of one school year. Although it is not within the scope of this paper to discuss the exact evaluation results, we do want to highlight some of the findings. The evaluations showed that among the major challenges in using data in schools are: the tendency of teachers to take action quickly (and not always based on data) and to think that the action will have an immediate impact; the length of the inquiry process; the need for whole-faculty involvement; the amount of time and effort required for the inquiry process; and resistance from teachers who do not fully understand how data can help them improve teaching and learning.

PLC members also stated that those who engage in a structured data-driven inquiry process should be aware that "data use" requires not only the analysis of qualitative and quantitative data, but also a commitment to an improvement process that requires time and effort. Collaboration requires a large level of involvement from *all* of the team members. Engaging successfully in the process of data-driven improvement also requires that all faculty members are willing to reflect upon and share their instructional practice and productively discuss the challenges in the school. These are not cultural norms in many schools, but they are absolutely critical to the process of

continuous improvement. Finally, the PLC members pointed out that using data in their school allowed them to see things that were not immediately evident, and that it has been worthwhile to collect data, analyze it, and collectively plan for concrete school improvements that will ultimately help prepare their students for academic success.

Acknowledgements. This paper includes parts of the report "Comparative analyses data use in Germany, The Netherlands, Lithuania, Poland and England" on the workpackage lead by Dr Kim Schildkamp, University of Twente and "Survey Data Analysis" on the workpackage lead by ifib Institute for Information Management, Bremen GmbH, authored by PCG Polska (PL), Specialist Schools and Academies Trust (UK), Modern Didactics Center (LT), University of Twente (NL), and the Institute for Information Management, Bremen GmbH (GE). All rights are reserved to DATAUSE project partners. The DATAUSE project has been funded with support from the European Commission. This paper reflects the views of the authors only, and the Commission cannot be held responsible for any use which may be made of the information contained herein.

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Part II

What Issues Do Those Developing New Educational Management Information System Face?

Computer-Based Large-Scale Assessments in Germany

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Abstract. In nearly all countries, technological changes in the field of digital media have raised great interest in procedures for testing students' performance by means of computer-based assessment. For extensive international tests (large-scale assessments) such as the Programme for International Student Assessment (PISA) or Trends in International Mathematics and Science Study (TIMSS), pilot studies with computer-based assessment were first carried out. In the context of national education systems, the question of feasibility plays a crucial role. Considering the framework conditions in Germany, scenarios for a potential nation-wide roll-out have been developed. Based on this, we evaluated the feasibility of technical and organizational factors.

Keywords: Computer-based assessment, large-scale assessment, feasibility study.

1 Introduction

With the emergence of international school performance studies (e.g. PISA, Progress in International Reading Literacy Study (PIRLS)), large-scale assessments (LSA) are frequently used as instruments for monitoring school quality and accountability. The tests can be used for different purposes, e.g. for generating data for educational policy-making, system monitoring, quality management for schools and indicators for measuring the performance of students. Thus they are strategic assets of empirical educational research and policy.

Referring to LSA, computer-based assessments are computer-based procedures that can be used for large-scale school performance studies, learning level surveys or the examination of educational standards [1 - 3]. They include software solutions as well as solutions with corresponding hardware platforms (e.g. mobile terminals such as a personal digital assistant (PDA), smart phones, or digital pens).

According to Hartig, Kröhne and Jurecka [4], computer-based assessments (CBA) run on a computer, but can also be performed on a local area network or based on Internet protocols. Many empirical studies have been conducted to analyse the difference between paper-and-pencil and computer-based testing – with varying results (e.g. [5 - 10]). From Hartig, Kröhne and Jurecka [4] we can conclude that computer-based and paper-and-pencil tests are comparable if the same conditions concerning the items and the test parameters are given. What is missing are empirical

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 41–54, 2013.

studies on the technical and organizational feasibility of transferring computer-based assessments to large-scale studies.

Economical advantages of testing have to be contrasted with the development of a suitable infrastructure. If adequate equipment already exists in the schools, the costs of test distribution and implementation, evaluation and feedback of results will be kept within reasonable limits. The question of testing fairness is brought up as another disadvantage of CBA. Discrimination, due to cultural, ethnical or gender reasons connected with the level of computer skills, is feared, which would question the validity of the test.

However, many advantages speak in favor of computer-based testing. Standardization of tests (using identical parameters, instruction and evaluation routines) improves quality criteria (objectivity, reliability and validity). Due to the information technology base, quick evaluation processes and an adaptive test procedure become possible.

Since the last PISA study, several experiments for representing the existing assessment process with computer systems have been carried out. Hence, any feasibility study has to be designed as a multiple cost-benefit analysis including suitability for the task, requirements of the information technology (IT) infrastructure concerning information security and data protection as well as operations, user support, usability and accessibility of software. For our study design, the leading question was to identify socio-technical scenarios, which are suitable for analysing the feasibility of computer-based tests in large-scale studies.

2 Scenarios for Computer-Based Testing in Large-Scale Assessments

For assessing the implementation potential of different international approaches in Germany, five scenarios were developed. The timeline was defined as the next ten years. The evaluation of the scenarios focussed on organizational implementation as a part of the social subsystem.

As a conceptual frame, we restricted the possible scenarios to the current activities in Germany for large-scale assessments. We considered VERA 3 and VERA 8, which are comparative assessments of student performance in all public schools in Germany in grades 3 and 8 in the main subjects of mathematics and reading. The tests are taken at the same time [11, 12]. Additionally, we took into account the assessment of educational standards identified by the Standing Conference of the Ministers of Education and Cultural Affairs of Germany (Kultusministerkonferenz). This is an assessment of a representative sample of students in grade 10 in the main subjects [13, 14]. Due to the sample size, the amount of simultaneous tests can be limited to 10,000 whereas the test formats VERA 3 and VERA 8 involve all students in these grade levels. The test setup always requires test administrators. The responsibility is divided between the organization of the test process and the management of the technological infrastructure, which can both be provided internally or externally.

In order to compare the demand for the IT network infrastructure such as bandwidth and server architecture, the potential number of participants (in parallel) needs to be calculated. As an assumption, we took the average number of classes per grade level and students per class. For VERA 3 in German primary schools, the average is three classes per grade level, with pupils evenly distributed across the grades and years. Per year, three or four classes of a grade are taught in parallel. The average class size is 22. As there is no central registry for IT infrastructure, we had to base the calculations on available numbers from 2008. Sixty-two percent of German primary schools (grades 1 to 4) were equipped with computer laboratories, and 82 percent with a stationary computer in each classroom. This can be summed up as nine students per computer on average [15].

For VERA 8, the assumptions are extended to secondary schools. In 2008, 98 percent of these schools were equipped with computer laboratories. There was one computer available for ten students on average [15]. Based on the assumption of four classes per grade level with an average size of 25 students, schools with a total number of students of 1,000 have the technical equipment for the implementation of the tests. The calculated numbers for the national tests on grade level 10 are identical (although it should be noted that values for all school types has been simplified; there certainly are smaller schools, which provide the required infrastructure to carry out computer-based tests, whereas some bigger schools do not).

The more students participating in the test, the higher is the bandwidth of the local area network needed as well as a faster connection to the Internet. On average it can be assumed that a download bandwidth of 100kb/s has to be provided per test person. The upload bandwidth can be disregarded inasmuch as a low amount of data has to be transferred back. Thus, in the case of 100 simultaneous tests per school, a connection of 16Mb/s should be provided at the location.

The scenarios developed were based on extensive literature reviews of existing approaches in other countries. We conducted expert interviews with representatives of the test administration and included questions on transferability to Germany. Additionally, several German experts were consulted.

2.1 Evaluation Criteria

For the evaluation of the scenarios, we developed a range of criteria, which were selected on the basis of an extensive literature study of international cases. We investigated the computer-based assessment methods of 16 different countries including the USA, Canada, the Netherlands and Denmark (e.g. [16 - 25]).

The first criterion was control over the process. This included the need for test centres to have an overview of the procedure from production to implementation to the return of the results (end-to-end) and the effect of this on security precautions and the assignment of responsibility in the case of problems. The second criterion was capacity and availability. This related to the amount of tests that could be taken simultaneously at one place and limitations, which arose concerning terminals, rooms, bandwidth, etc. The next aspect was standardization versus heterogeneity. How great is the reliance on hardware (memory, processor, graphic card)? Which are the

(uniform) configurations at the location? For the analysis of the fourth criterion it was important to consider all legal requirements concerning information security (e.g. integrity, authenticity, availability, non-repudiation) and data privacy (e.g. active acceptance by users, control of access, admittance, availability and the principle of separation).

Furthermore, logistical aspects concerning preparation and implementation had to be taken into account. Questions like how are the devices ("virtual test booklets") transported to the test place and how are the devices securely placed, who ensures availability, who provides technical and administrative support at the location, who collects the devices and how are they transferred; these all arose in connection with this criterion.

One distinctive aspect between the organisational and technological scenarios addressed the qualification requirements for test takers as well as administrators and technical staff. This included programs for teachers and the test administrators as well as the provision of training materials for students. The last criterion was the cost aspect, including different cost categories of the scenarios, like direct costs (procurement, infrastructure, etc.) and indirect costs (support, insurance, etc.).

2.2 Scenario 1: Local IT-Infrastructure

In this scenario, the existing technical infrastructure of the respective schools was used, i.e. devices in computer laboratories or libraries. The tests were carried out in these rooms or in larger rooms such as the assembly hall or the gym. The software was provided either as a web-based application via the Internet or via a local mobile server using the existing local area network. Test administrators were needed for organization as well as IT experts for the provision, maintenance, setting up and restructuring of the infrastructure. The effort for the teachers stayed the same as in the case of paper-based tests. The identity check on students who took the test was carried out by local staff (teachers). Normally special measures (e.g. a check of an identity card) were not required.

Existing IT infrastructure was assumed to be heterogeneous. Schools worked with different client-server systems, the software differed and the quality of the existing hardware varied from school site to school site. Ninety-nine per cent of schools had some sort of Internet access. However, the availability of local area networks was significantly lower: in primary schools approximately 60 per cent, in secondary schools about 84 per cent. Currently, there were no reliable data about the bandwidth of the internal or the external connections. The majority of schools in rural regions were connected to the Internet via a sponsorship program of Deutsche Telekom AG with DSL quality (1-10 Mbit/s). However, many larger cities served as network providers to their schools and offered higher bandwidth (10-100 Mbit/s per school).

Concerning the organisation, the main focus (analogous to the paper-based test procedure) was on the training of the test participants with decreasing effort in the higher-grade levels. The qualification of teachers concerning the handling of digital media differed very much depending on school type. Technical administration by

teachers could be found in most secondary schools; in primary schools there was no such support. Depending on the local school authority, additional technical support was offered. Hence, this scenario needed to rely on high-skilled technicians at the local level.

Another challenge was the preparation and qualification of the test administrators. The existing paper-based procedures for the three selected tests in Germany were not administered centrally. Hence, support structures had to be provided, which implied additional resources. Furthermore there was a need for qualified IT administrators in the schools or at the school district to ensure the availability of the IT infrastructure during the test phase.

Table 1. Evaluation of Scenario 1

Criteria	Strength (+) or Weakness (-)
Control of the Complete Process	- Control of implementation remains the responsibility of the school - Depending on the local school authority, there are fixed infrastructure standards which have to be considered
Capacities and Availability	- Limited capacities, depending on school equipment - Not all rooms sufficiently equipped (especially in primary schools) - Bandwidth varying (local city networks/sponsoring)
Standardization vs. Heterogeneity	- Very heterogeneous infrastructure (operating systems, software, hardware) - Technical standardization not enforceable - Different configuration at every location
Information Security and Data Protection	- Realization requires much effort - Strongly dependant on local conditions - Know-how can hardly be expected on site (perhaps even opposes the security policy of the school authority)
Logistics – Preparation and Implementation	+ Easy organization if existing rooms can be used - Technical support has to be ensured (different situations in the schools) - Lacking technical know-how when devices are combined to an internal test-centre (e.g. assembly hall)
Qualification Requirements	- Comprehensive qualification required: Test administrators (technically) and teachers
Qualification Requirements for Students	+ Familiar environment, devices + Small exercise efforts
Costs	+ No procurement costs, no hire charges for the devices - Additional equipment for badly equipped schools required - Technician required when devices are combined to an internal test-centre (e.g. assembly hall)

2.3 Scenario 2: Test Centre

Universities provide test management for computer-based assessments in test centres. For example, the Brigham Young University in Utah, USA, provides its test center for any interested party. Forty computers are available for online testing.

This scenario deals with the use of adequately equipped rooms located in public or commercial institutions. Generally this scenario is conceivable in four different forms, involving computer laboratories:

- Of educational institutions (schools, universities).
- Of public institutions (centres for adult education, libraries).
- Of commercial service providers.
- Under school management.

The provision of the test environment can also take place in different ways. This includes the use of a web-based application on a central server via the Internet and the provision of this application on a mobile server using the local area network. Concerning staff, this scenario requires test administrators to secure the organizational process at the premises. Technical support can be provided by local IT administrators. Admission control is checked by mechanisms of authentication such as identity card control or knowledge control (username and password).

The implementation of the technical part of the scenario is the same for all test examples. The provision of sufficient workplaces in computer laboratories is a prerequisite for the simultaneous test of all participants. Based on the assumed average values, this means that a sufficient infrastructure has to be provided for 75 students in primary schools and 120 students in secondary schools. In metropolitan areas such as Berlin, 25,000 pupils would have to be brought to appointed locations to be examined at the same time. This appears to be an enormous expenditure. Thus the necessity of simultaneity is decisive. If time-shifted test formats are possible, this scenario would appear to be more realistic. Therefore we have to differentiate between the ways of testing; for a sample-based survey (such as the survey of national educational standards) it would be possible to find adequate test centres due to the limited number of test participants. As the tests are not taken simultaneously, a time-shift would be possible. Thus, not only the number of test administrators could be reduced, but also the search for test centres would be easier.

In the context of this scenario (except the provision of special rooms in a school) an internal network and broadband Internet can be expected as well as the protection against failure and the adequate provision of spare devices. More expenditure is generated by the organisation of the tests. Logistics especially (acquirement of capacities, allocation of resources, transport and supervision of the students) should be considered. Central training of test administrators in test centres could reduce the workload for teachers.

In summary, the logistic expenditure in primary schools (VERA 3) is highest with regard to transport and supervision of the participants. It decreases with increasing age and grade level of students (VERA 8).

Table 2. Evaluation of Scenario 2

Criteria	Strength (+) or Weakness (-)
Control of the Complete Process	+ High degree of control of test production, implementation and return of results
Capacities and Availability	+ High availability + Reliable IT- and network infrastructure - Limited capacity (urban-rural divide)
Standardization vs. Heterogeneity	+ Homogeneous systems + Standardized infrastructure - Differences between locations
Information Security and Data Protection	+ Easy control (e.g. authentication) + Use of existing know-how + Established procedures
Logistics – Preparation and Implementation	- A lot of organizational effort: Reservation and allocation; transport of students (long distance) - Urban-rural divide
Qualification Requirements: for test administrators and teachers	+ Technical administrators on location + Probably organizational qualification requirements for teachers (only attendance)
Qualification Requirements for Students	- Unfamiliar environment and devices - No opportunity for exercise
Costs	- Rent - Transport of students - Staff costs on location

2.4 Scenario 3: Mobile Test Devices

The use of mobile test devices by test participants is logistically a digital version of paper-based test booklets. Test administrators have to transport the necessary infrastructure to the test locations and these are distributed to the test participants and collected after completion. Laptops, netbooks or other mobile devices with touch screen technology like tablets could be used as client systems. The test application is provided either by proprietary installation on the devices or by provision via the Internet or the use of mobile servers. When provision via the Internet is chosen, the local network has to be accessible. This requires corresponding network bandwidths. For this scenario it is necessary that test administrators provide technical and organisational assistance. The identity check of participants can be carried out by local staff.

From a technical point of view, the provision and acquisition of the required infrastructure is the critical success factor. If we refer to the numbers of 2008, on average 75 devices per primary school and 120 devices per secondary school have to be provided. Logistical issues especially concerning the delivery and collection

as well as the subsequent use of the devices have to be considered. Additionally, the procedures for organizing the return of the test results have to be considered. When the mobile devices are used within the school, the test data have to be collected, saved and analysed centrally. This produces high technical and organisational expenditure.

The local technicians are responsible for the provision of the basic infrastructure. This includes the availability of enough electrical connections for recharging the client systems and the possible use of the existing network infrastructure including Internet access. In this case, Internet access and the local area network (LAN) in the schools have to be regarded as a second critical success factor. A wireless LAN especially has to be provided for the mobile devices. Currently, there are no data available on the diffusion of wireless LAN in German schools, but it can be assumed that wireless LAN is not available in all locations – in primary schools even less. To use this scenario for comparative studies, the local infrastructure and the Internet connections in primary schools have to be expanded.

Table 3. Evaluation of Scenario 3

Criteria	Strength (+) or Weakness (-)
Control of the Complete Process	+ High degree of control of test production, implementation and return of results - For network access, coordination with IT officer in charge required
Capacities and Availability	- Capacity depends on number of terminals + High degree of availability of proprietary software - Availability depends on local infrastructure in case of web-based software
Standardization vs. Heterogeneity	+ Homogeneous systems + Standardization largely possible
Information Security and Data Protection	+ Easy control (e.g. authentication) + Established procedure (closed systems)
Logistics – Preparation and Implementation	- High efforts for delivery and collection of the devices (especially with simultaneous tests) - Installation of devices requires technical know-how
Qualification Requirements: for test administrators and teachers	- Technical qualification of test administrators mandatorily required - Qualification of teachers required as regards content
Qualification Requirements for Students	- Unfamiliar handling and devices - Lacking opportunity for exercise
Costs	- Procurement (incl. spare devices) - Insurance - Transport - Technician and qualified test administrators on location

From an organizational point of view, sufficient training of test administrators has to be ensured. Due to the variety of the client systems, training on the use of the software, the basic handling of the device and trouble-shooting has to take place. The training of test participants is similar to that in previous scenarios.

2.5 Scenario 4: Use-Your-Own-Device

The concept "use-your-own-device" addresses the fact that more and more students have access to individual mobile computers. According to Medienpädagogischer Forschungsverbund Südwest [26], 80 per cent of young people in Germany aged 12 to 16 years have a computer or laptop of their own. Hence, test participants could use their own hardware. It would be essential to ensure that hardware is operational, i.e. a definition of minimal requirements is needed. This has to be done before tests are conducted, e.g., by a previous certification of the hardware by test administrators at the location. Apart from these requirements, this scenario is similar to Scenario 1, except that the school computers are replaced by private hardware.

As a second, more visionary sub-scenario, private computers could be used for testing in a familiar environment at home. In this case the test environment is provided with a web-based application via the Internet. In order to ensure equal access and use, test administrators are needed to train the participants. Technical support can be provided through a central point of contact (hotline, or service desk). The key success factor in this sub-scenario is authentication: it could be effected by knowledge control (password) and, if applicable, by biometrical features (fingerprints, or iris scan). Even using the new German electronic identity card could be considered. Furthermore, it is necessary to ensure that the participants work on the test individually and without help, according to the test instructions. This is possible by visual control via the network infrastructure and reliable applications (e.g. camera), though this will directly influence minimum requirements for the hardware. Additionally, the intrusion into private homes may have implications for privacy.

From a technical point of view, the question is if and how far the test participants have a suitable infrastructure available in their private environment. Although in 2010, 81 per cent of German households had a stationary or a mobile computer, this does not show whether this equipment meets the requirements for electronic testing. Furthermore, it was recorded that 73 per cent of the households had Internet access. The bandwidth varies between German regions (Statistisches Bundesamt Deutschland 2010) [27]. Additionally, access to computers and the Internet varies in relation to the income of the households. In a survey in 2008, only half of low-income families had a computer with Internet access (Statistisches Bundesamt Deutschland 2009) [28]. Given this, it is a legal question as to whether a test can be mandatory when privately owned devices are a prerequisite.

Another challenge is the standardization of the test conditions in terms of hardware and software in order to provide a fair test. It is hardly possible to standardize the types of privately owned devices as well as the bandwidth of the Internet connection.

Table 4. Evaluation of scenario 4

Criteria	Strength (+) or Weakness (-)
Control of the Complete Process	- The school and the test participants are responsible for implementation - In case of network access, cooperation with the IT officer is necessary
Capacities and Availability	+ All students can be tested simultaneously - Not all of the students own a device (spare devices are required) - Dependent on the infrastructure of the school (such as in the case of local infrastructure)
Standardization vs. Heterogeneity	- Very heterogeneous infrastructure (operating systems, software, hardware) - Technical standardization not enforceable - Each student has a different configuration.
Information Security and Data Protection	+ Easy to control access (authentication) - Impossible to control access (private devices)
Logistics – Preparation and Implementation	+ Low expenditure (effective time management essential) - Technical support has to be ensured
Qualification Requirements: for test administrators and teachers	+ No test administrators required - Comprehensive qualification required for school staff
Qualification Requirements for Students	+ Familiar environment + Students can practice in their home environment
Costs	+ No procurement costs - Additional costs for spare devices (such as insurance)

2.6 Scenario 5: Digital Pens

Technically, digital pens are a combination of an input device (pen and camera) and the corresponding digital paper. Digital pens look like conventional pens with an integrated digital camera filming the environment of the pen tip and thus registering where the pen is used. By means of corresponding software, forms are generated and printed as a greyish grid on paper. This is possible with a common laser printer. With the help of the grid, the camera and the special software, it is possible to identify the exact location of the pen tip. The user fills in the sheets in the conventional manner; the digital pen records the entries (pictures and text can be recorded as well). The content can be transmitted via Bluetooth or a docking station. The previously defined documents allow the data to be automatically entered into a database. This approach has been used already in higher education for small-scale assessments (e.g. [29, 30].

The advantages of digital pens are obvious: there is no need to train participants, the school staff and the test administrators. The pens are easy to deal with and relatively cheap (less than 100 Euros). Scientific formulas, continuous texts and

handwritten commentaries can be recorded as well as audio annotations. The algorithm for character recognition works best with multiple-choice questions. Therefore the pens and the test booklets can easily be handed out and collected.

Up to now, however, the technology is not mature enough to deal with complex applications in real-life environments. The pens have been tested during elections or in health care scenarios [31] but could not meet high security requirements. Storing of changes on a page or returning to previous pages especially cannot be ensured. Although the devices are cheap, costs for licences for pattern generation on the paper are high. Distinctions are made between unique patterns and copied patterns. The former are reproduced for each page and therefore allow a direct assignment between the pen (user) and the page – and have to be paid per page. The latter can be copied as often as necessary, but then the user has to mark in the booklet on which page he/she is working. The first model is expensive; the second model fails in terms of usability.

All in all, despite all obvious advantages of the technology, it is not yet sufficiently developed for the use in computer-based assessment because of technical problems and resulting organisational difficulties.

Table 5. Evaluation of Scenario 5

Criteria	Strength (+) or Weakness (-)
Control of the Complete Process	+ High degree of control of test production, implementation and return of results
Capacities and Availability	+ High degree of availability + No room limitations - Good printer required at each location
Standardization vs. Heterogeneity	+ Uniform system - Software not yet ready for the market
Information Security and Data Protection	+ Easy control (e.g. authentication) + Established procedure (closed systems) + Additional security through paper
Logistics – Preparation and Implementation	+ No difference to paper based tests, if printed at school + Supply and collection of devices
Qualification Requirements: for test administrators and teachers	+ Short technical introduction by test administrator required
Qualification Requirements for Students	+ Familiar handling + Exercises on paper (without DigiPen) possible
Costs	+ Procurement of terminals (incl. spare devices) - License costs

3 Conclusions

Some of the German experts we consulted said spontaneously that in their opinion computer-based large-scale assessments would not be feasible in Germany in the

foreseeable future. Although they agreed on the potential it held for adaptive testing for high-stakes needs and for the motivation of students, they were sceptical as to whether the necessary cooperation between the federal authorities and the states and among the local authorities in the states could be effected, considering the federal education system. This reflects the special situation in the German education system with its separation between internal and external school issues. Neither the federal authorities nor the federal states can determine the IT infrastructure and provide technical support. They can only define requirements on the basis of curricula or via legislation, which have then to be implemented by the local school authority. If the states assign new tasks to local authorities, they need to provide the necessary funding. This requires complex negotiations between the state and the local education authorities. In some of the international cases, the implementation of computer-based testing initiated large-scale equipment programs for the schools. Whether such a strategy could be implemented in Germany is doubtful. Direct funding of schools by federal authorities is hardly possible and also requires a coordination process, as the local authorities will then have to pay all running expenses.

The results of the international comparison as well as the scenario-based assessment of the organisational framework conditions offer a more optimistic perspective. However, the positive effects of computer-based test procedures can only arise if basic questions of data privacy, information security, and accessibility can be clarified by software manufacturers, and if local education authorities responsible for providing the IT infrastructure are involved in the concept at an early stage.

For the use of IT infrastructures in schools (Scenario 1), two preconditions have to be fulfilled: first, schools have to be provided with appropriate equipment; and second, the local school authorities have to organise the required IT support processes. During the coming years, the IT infrastructure will increase and central IT services (e.g. utility computing in the cloud) will be available. These could then be used for CBA.

With test centres (Scenario 2), these problems could be solved, but here logistic requirements concerning transport of pupils and an urban-rural divide will arise. Due to high costs, it will hardly be possible for test organisers to build up test centres of their own.

Mobile test devices (Scenario 3) are also not suitable for large-scale tests, as they depend on the unreliable local infrastructure of the schools and are expensive.

The vision of “use-your-own-device” (Scenario 4) in the school context may be fulfilled within the next ten years. How far students will (want to) really have their own devices used, and if those will be suitable for computer-based tests, cannot be predicted. In any case, the test organisers, the schools and the local school authorities will have to bear any additional costs to make available the appropriate network infrastructure and the necessary technical support.

When the software for digital pens (Scenario 5) has reached a higher level of maturity, this will be a serious alternative, even if the cost saving compared to the paper-based tests would be rather low and adaptive test procedures could not be carried out. Thus, none of the five scenarios are realizable today.

Computer-based testing for large-scale assessments is a complex socio-technical system, which can only be realized by systematic planning and intelligent collaboration of test provider, software producers, local school authorities, state departments of education and schools.

Acknowledgements. We would like to thank Heiko Sibberns (IEA-DPC Hamburg), Peter Harych (ISQ Berlin-Brandenburg), Heiko Rölke (DIPF Frankfurt), Annemarie Klemm (SfBWG Bremen) and Mark Henning Tonne.

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What Needs to Be Done for Successful E-Assessment Implementations?

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Abstract. Assessment is one of the most important parts of the education system. The effectiveness of teaching and learning needs to be assessed so that all parties involved in this system can be improved. When "Assessment" is powered with technology and named as "E-Assessment", generating the data to make the necessary improvements in education gets easier. However, as is the case in other fields, technology brings risks and challenges along with its indispensable benefits. This paper provides insights about success factors that are extracted from the literature and validated through a Delphi study. With the participation of eleven experts in two iterative rounds, in addition to the success factors, practicable solutions to achieve success are also collected. The decision makers who plan the implementation and administration processes of E-Assessment can consider the proposed key success factors and the practicable solutions when allocating resources.

Keywords: E-Assessment, Delphi method, success factors.

1 Background

The use of technology in educational assessment is quantitatively increasing. In the three decades since the first generation of computer-based tests took place in the United States (US) [1], many countries have delivered their formative and summative examinations in electronic form (e.g. see [2] for the US; [3] for the UK; [4] for the Netherlands and [5] for Australia). One of the major international surveys, the 'Programme for International Student Assessment" (PISA), intends to move completely to electronic mode by 2015 although "there are still a lot of open questions to be discussed" [6, p. 7].

E-Assessment can be defined as digitizing any assessment-related activity [7]. E-Assessment can make the whole assessment process more efficient and provides numerous possibilities, which cannot be achieved with traditional paper-pencil assessments. For example, test scores can be received quickly (sometimes almost immediately) [8], richer assessment data for decision making can be collected [9] and consistency in marking can be ensured [8].

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 55–66, 2013.

Considering the benefits and challenges of E-Assessment and also some of the open questions in the field, the study presented in this paper addresses the following questions:

- What are the most important organizational and technical success factors of E-Assessment?
- What is the order of perceived importance of these factors according to experts' opinions?
- What are the practical solutions for achieving the proposed success factors?

This empirical study will validate the relevance of identified success factors and explore new and context-specific ones. Thus, decision makers who plan the implementation and administration processes of E-Assessment can utilize the identified and ranked success factors in this study while allocating resources for their projects.

2 Methodology

2.1 Data Acquisition: The Delphi Method

The Delphi method has been applied in a wide variety of fields [10] as a decision making tool to deal with complex problems [11]. It is an approved technique in information systems research [12, 13] and has been used broadly "to identify and rank key issues for management action" [14, p. 763] which is one of the objectives of this study. In spite of the different applications of the method, there are three common features of Delphi procedures identified by Dalkey (1969): anonymity; statistical group response' and iteration with controlled feedback [15].

Participants are kept anonymous from each other so they are not affected by dominant respondents [10]. Because participants are not anonymous to the researcher, the answers can be tracked in case follow-ups are needed [10]. Individual contributions are aggregated and the group's judgment is assessed through statistical procedures in order to ensure the reliability of the results [16]. The iterative process is built by basing each round on responses to the preceding round. Feedback is given to the group at each round with a summary of the results and respondents have a chance to revise their answers by considering the group's views on the subject [10].

Delphi Administration: The Delphi process usually has four phases which can be summarized as exploration of the subject, understanding the view of the group, resolving significant disagreements and final evaluation [11].

For the first phase of the study, to explore the subject, an initial set of success factors was identified through a literature review. Journal, conference and workshop papers, technical reports and books were collected using the search term "E-Assessment" and other relevant terms (e.g. "computer-based test", "online assessment", "technology-based assessment") on online databases. The criteria for the document selection were that these documents had some relevance to the implementation of E-Assessment with the focus of organizational and/or technical issues.

In the second phase, views of experts were collected through an online questionnaire. Participants were asked to rate the importance of values of success factors based on a 5-point Likert scale ranging from "Unimportant" to "Very important". Respondents were also asked to add key components for each success factor.

The second iteration was based on the results of the first one and used to resolve disagreements and improve the reliability of the results.

In the final phase, the results of the two rounds of questionnaires were analyzed and documented.

Identification of the Experts: The participant selection criteria for this study were that the candidates would either have relevant publications or have been actively involved in a number of relevant projects.

Eleven out of eighty expert candidates initially contacted participated in the study. Delphi studies, differently from traditional surveys, do not depend on representative sample size since they require contributions of qualified experts who have deep knowledge on the subject [10]. For this reason, eleven was considered reasonable and invitations to the second round were only sent to those experts who took part in the first round.

2.2 Data Analysis

"There are many different views on what are the 'proper', 'appropriate', 'best' and/or 'useful' procedures for accomplishing the various specific aspects of Delphi" [11, p. 3]. It has been suggested that consensus can be determined by examining the aggregate of judgment and the convergence of opinion [17]. In this study, the evolution of consensus between two rounds had been observed as a central tendency and convergence of opinions by checking the movements in mean, median, standard deviation (SD) and percentage response rates [16, 18]. The mean, as a measure of central tendency, represents the group opinion. The standard deviation, as a measure of spread, represents the disagreement level [18]. High SD values mean high disagreement. Percentages for each level of the importance scale are used to assess convergence of responses.

Qualitative coding [19, p.81] (using both deductive [19] and inductive [20] approaches) was used to analyze the free-text responses in order to expand the list of success factors and their key components by deriving new elements from the dataset.

3 Initial Set of Success Factors

In this section, the initial set of success factors which formed the base of the first round questionnaire is explained. Short descriptions and some of the practical solutions resulting from the literature review are presented for each success factor. Organizational factors tend to deal with managerial issues such as policy, planning, structure and human resources. However, technical factors tend to deal with specification, acquisition, development, use and protection of hardware and software tools.

3.1 Organizational Success Factors

Human Resources: Specifying roles and responsibilities of personnel is a 'must' for the success of computer-based assessment systems [21]. Cooperation among assessment, learning and technology staff was indicated as an important driver in successful E-Assessment implementation [22]. Training has also been pointed out as one of the most important tasks [8, 22].

Institutional Support: Effectiveness is dependent on institutional support [23]. Funding is inevitably required [24].

Administration Support: Technical support should be given throughout the assessment process [25, 26]. A "Service Center" can help to solve technical problems quickly and prevent further issues, possibly via telephone [27, 28]. Documentation such as administration manuals and quick reference sheets can be disseminated to help out with common technical issues [27].

Risk Management: Managing risks has paramount importance [21]. Pilot tests can be used to identify and analyze the risks [21, 27] and emergency plans can be formulated [22]. Having spare computers and paper-based options is suggested [21, 25].

Continual Improvement: The effectiveness of E-Assessment projects is dependent upon "a long range plan for sustainability" [23, p. 16]. Stakeholders' and examinees' needs should be considered to make improvements in the E-Assessment system. Service center call logs can be analyzed to get the recommendations for changes and improvements; also post administration surveys can be conducted to directly ask for suggestions [29].

3.2 Technical Success Factors

Assessment System Features: The features of E-Assessment software tools affect all phases of the assessment process [8, 30]. The assessment software platform should support the design of a variety of question types and be an open source platform which is available for free use [30]. Collected data must not be lost in case of any system failure [2, 31, 32].

Testing Room: "An obvious but nevertheless important need for computer-based tests is the test administration sites" [32, p. 2]. It should be quiet and comfortable [5, 22, 33]. Proper lighting is needed to prevent glare on the computer screens [22, 24].

Connectivity: Adequate bandwidth is one of the crucial factors [22, 28, 29]. A wired internet connection is recommended for reliability [31, 33]. In order to deal with low bandwidth, local caching software is used [28, 33] or the data are downloaded on to PCs [34].

Security: Ensuring security is critical [30, 35]. Assessment data including personal registration information, questions and scores need to be secured throughout the

administration [4, 27, 31, 35]. Secure authentication [4, 34, 35] and protection against viruses and hacking attempts [26, 34] are of utmost importance.

Interoperability: "Interoperability is about portability" [22, p. 18]. E-Assessment materials must be portable between different platforms and learning management systems [8, 26] so assessment resources can be shared and reused [22].

Accessibility: Accessibility has to be taken care of [9, 27, 35]. Necessary accommodation should be provided including extra time [9], Braille versions [9], alternative hardware [32] and software adjustments [27]. The design of the E-Assessment project must comply with legal requirements [26].

Usability: Ease of use of the E-Assessment system is another crucial factor [32, 34]. An intuitive interface design is needed for non-technical personnel in item authoring [30]. Also, examinees should be able to concentrate on the test items instead of spending time understanding how to navigate or how to indicate a response [32].

4 Findings

4.1 Participants' Profile

The E-Assessment project directory (see `http://www.dur.ac.uk/smart.centre1/jiscdirectory/page_06.htm`), which was used to recruit some of the candidates, mostly consisted of projects in the United Kingdom (UK). Therefore, not very surprisingly, almost all of the participants (10 out of 11) are academics who work in universities in the UK. Only one participant works in a research centre in Greece and all participants except one practitioner have several publications in the field. The expert panel is very homogeneous and the results of the study largely reflect a UK perspective. In their publications, they summarize their work in relevant projects or effective and innovative practices of E-Assessment in other projects through case studies. Some of the publications are literature reviews which are the proof of participating experts' theoretical knowledge in the field. One of the participants conducted an adapted version of a Delphi study in 2006 as a forecasting method to probe visions about the future of E-Assessment [21]. A few other participants have been involved in some projects of the Joint Information Systems Committee (JISC) (e.g. E-Assessment glossary [36], Case studies on effective practice with E-Assessment [37], Case studies on advanced E-Assessment techniques [38], and A guide to technology-enhanced assessment and feedback [3]).

4.2 Ranking

According to the results of the second round, the five most important success factors are *Security, Assessment System Features, Accessibility, Institutional Support* and *Connectivity*. *Institutional Support* is the only organizational factor among the top 5 most important success factors, and in contrast to the findings of Conole and

Warburton (2011), the experts in this study found technical factors outweigh organizational issues [8].

The rankings of the success factors for both rounds are presented in Table 1. For all of the success factors, the SD values were either the same or decreased in the second round compared to the first. This confirms the evolution of consensus between successive rounds.

There are slight decreases in the mean ratings of almost half of the success factors. Nevertheless, on average, respondents perceived the proposed success factors important for implementing E-Assessment projects. When the respondents were asked to comment on the ranking based on the first questionnaire results, they reflected that the ranking was generally fair.

Based on participants' comments on the definitions of success factors, *Administration Support* was split into two factors as *Administrative Support* and *Technical Support*.

Table 1. Importance of ranking of success factors listed by second round ranking order

	Round One (N=11)				Round Two (N=11)			
Success Factor	**Rank**	**Mean**	**Median**	**SD**	**Rank**	**Mean**	**Median**	**SD**
Security	#1	3.73	4	0.65	#1	3.73	4	0.65
Assessment System Features	#3	3.46	3	0.52	#2	3.64	4	0.50
Accessibility	#7	3.18	3	0.98	#3	3.18	3	0.98
Institutional Support	#7	3.18	3	0.98	#4	2.91	3	0.54
Connectivity	#10	2.64	3	1.50	#5	2.82	3	1.08
Technical Support	N.R.				#6	2.73	3	0.65
Continual Improvement	#6	3.18	4	1.25	#7	2.73	3	1.01
Risk Management	#9	2.91	3	1.38	#8	2.46	3	1.13
Administrative Support	N.R.				#9	2.36	2	0.92
Human Resources	#4	3.27	4	1.19	#10	2.27	2	0.90
Interoperability	#11	2.09	2	0.94	#10	2.27	2	0.90
Testing Room	#8	3.09	4	1.22	#11	2.00	2	1.10
Usability	#2	3.46	4	0.82	N.R.			
Administration Support	#5	3.18	4	1.08	N.R.			

Notes: SD: Standard deviation; N.R.: Not rated.

The items are ordered by mean first, then by median and then by SD in the case of ties.

0=Unimportant, 1=Of Little Importance, 2=Moderately Imp., 3=Important, 4=Very Imp.

5 Discussion

In the following section, the details of the results, key components and practical solutions, are presented in Tables 2 to 6, showing the results of the literature review and the Delphi study. The list of items in these tables can be used as a checklist for improving the success of E-Assessment implementations.

5.1 Top Five Success Factors

Security: *Security* was ranked as the most important success factor in both rounds. There is neither convergence nor divergence in the distribution of responses because the percentages for each importance level value remained the same. A low SD (0.65) confirms the high consensus on this factor. One of the respondents pointed out that *Security* is essential for the entire process to be stable and another noted that *Security* "leads to confidence in the system". It was also highlighted that the importance given to *Security* depends on whether the test is summative or formative. For formative low stakes assessments where providing feedback is the main goal, some security issues remain important but they are not as vitally important as in summative tests.

Table 2. Key Components and Practical Solutions for *Security*

Key Components		Practical Solutions
Secure storage & transmission of data	• Security of questions, answers & data**	• Loading examinations on the server in the last minute • Isolated network of server (questions) • Protocols to remove questions from the PCs • Protected answer file directories on server • Software features to prevent: print, copy, send, download • Fragmentation • Time protected files • Password protection • Proxy server • Encryption**
Secure authentication		• Pre-registration of computers • On-site photo of examinees • Fingerprint • Retinal scan • User name and password • Attestation statement • Valid photo ID
Prevent cheating		• Privacy screens • Large item banks and random questions • Video and audio taping • Isolated network of student machines • Cardboard carrels • Video and audio surveillance equipment • Deleting browse history
Protect against viruses & hacking		• Firewalls • Virtual private networks • Encryption

Note: Items with ** were mentioned by experts and in the literature; items with * were mentioned only by experts; and the rest of the items were mentioned only in the literature.

Assessment System Features: In the first round, respondents were asked to rank *Usability* as a separate success factor from *Assessment System Features* but the answers to open-ended questions suggested a merge between these two factors. In the second round, *Usability* was presented as a key component of *Assessment System Features* and ranked as the second most important success factor. This might be caused by the merging, since *Usability* was also ranked high in the first round. The low SD values of both rounds show that there is high consensus on the importance of ratings for this factor. The importance of usability features for authors was emphasized by the respondents. They noted that scheduling, easy marking and reporting features would make life easier for authors. A wide variety of question types and flexibility were also mentioned as important components of E-Assessment systems by five participants.

Table 3. Key Components and Practical Solutions for *Assessment System Features*

Key Components		Practical Solutions
Usability**	For authors**	• Item templates • Style sheets • Easy marking* • Scheduling features* • Multimedia usage* • Reporting features*
	For examinees**	• Practice tests and items • Help options • Video tutorials • Instruction screens**
	General**	• Software evaluations • Usability heuristics • GUI design standards**
Flexibility**		• Cross-platform compatibility • Various question types**
Adaptability**		• Modular design • Open coding**
Robustness**		• Using minimum hardware resource
	Preventing data loss**	• Recovery from system failures • Back up assessment data

Accessibility: *Accessibility* shows a rather divergent response pattern. The responses range between "Very Important" and "Of Little Importance". A slightly high SD (0.98) is also a sign of low consensus. Nevertheless, it was ranked in the third position due to its high mean value.

Three respondents stated that they expected to see *Accessibility* in a higher order when they were given the results of the first round. They also added that *Accessibility* is often neglected. Four respondents highlighted the importance of legal requirements in the UK because institutions have to adhere to the Special Educational Needs and Disability Act while preparing teaching and learning materials [39].

Table 4. Key Components and Practical Solutions for *Accessibility*

Key Components	Practical Solutions
Hardware & Software**	• Alternative input devices • Larger monitors • Braille versions** • Adjustments on the interface**
Allowances**	• Extended testing time • Individual rooms* • Amanuensis support*
Legal requirements**	

Institutional Support: Mean values show that *Institutional Support* became less important to the respondents. The percentages of responses for "Very important" and "Important" varied appreciably. Also, a convergence occurred between two rounds. The decrease in SD showed a movement towards consensus.

In the first round, *Institutional Support* was defined as "the top management's support on the implementation". In the second round, when only the collected key components were presented instead of the short definition, one of the respondents commented that "Now I understand that this category includes funding, I think that it is more important than I may have first thought". It is assumed that this was not the case for the other respondents because we would expect an increase in ratings instead of the slight decrease that occurred in the second round.

Table 5. Key Components and Practical Solutions for *Institutional Support*

Key Components	Practical Solutions
Funding**	• Hardware /infrastructure*
Developing awareness*	• Institutional strategy* • Institutional policy*
Coordination*	• Planning • Organization*
Analysis & monitoring*	

Connectivity: A modest fall in SD values confirms the convergence and thus the evolution of consensus. In the second round, more respondents found *Connectivity* important and this change resulted with a slight increase in mean rating. In the second round, respondents were presented with the key components of *Connectivity* (fast response and robustness). Based on their comments in the second round, we can assume that the poor agreement occurred because some of the respondents did not think about these components in the first round.

Table 6. Key Components and Practical Solutions for *Connectivity*

Key Components	Practical Solutions
Fast response**	• Copying data onto PCs • Local caching software/server**
Robustness**	• Wired connection • LAN

6 Limitations

This study has involved a small sample size and the participant profile is very homogenous (10 out of 11 are from the UK). Therefore the results should be treated with caution. In some Delphi studies participants are recruited from certain countries and they are grouped in panels (e.g. Hong Kong, Finland and US panels in [13]). The results from each panel are compared and interpretation can be considered accordingly. We can assume that this Delphi study consists of a UK panel and if it is followed by a larger study, the results can be compared with other panels.

This research focused on only organizational and technical success factors but with success factors from other dimensions (e.g. pedagogic/psychometric), a bigger picture could be seen.

7 Conclusions

This study empirically identified and validated the organizational and technical key factors affecting the success of E-Assessment projects. The Delphi method was used to analyze and rank these factors through two rounds of online questionnaires. The data were collected from a panel of experts who had been involved in a number of E-Assessment projects and/or had relevant publications. Eleven experts participated in both rounds. The top five factors among twelve were *Security, Assessment System Features, Accessibility, Institutional Support* and *Connectivity*. The expert panel identified a number of key components and practical solutions which were not recognized in the literature review. These findings can assist decision makers when implementing E-Assessment projects and allocating resources.

Acknowledgments. The author would like to thank all the participants for their generous contribution of views and time.

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Investigation of the Knowledge Management Process of Schools in Turkey

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Abstract. The aim of this study was to identify the opinions of administrators and teachers about the knowledge management process in primary, secondary and high schools. The population of the study was teachers who work in primary, secondary and high schools in Kocaeli, Izmit. The sample of the study was 270 teachers that were randomly selected. The Knowledge Management Process in Schools Scale that was developed by the researcher was used to collect data. The reliability rate of the scale is 0.96 Cronbach Alpha. The Knowledge Management Process in Schools Scale's Descriptive Factor Analysis results revealed that the scale was comprised of six factors. These factors were: obtaining knowledge; using knowledge; learning knowledge; sharing knowledge; evaluating knowledge; and administrative support. The results of the study revealed that administrative support played an important role in the knowledge management process, and the participants' opinions varied according to their years in service, age and gender.

Keywords: Information management process, school, teacher.

1 Introduction

Rapid economic, cultural, social and technologic changes in the world mandate modifications in educational systems in many countries. The information age compels development and change in every organization including educational organizations and we have observed educational reforms in Asian-Pacific countries as well as in other parts of the world [1, 2]. Also, on an international level, effective school movements and school-based administrative movement reforms have taken place [3, 4].

In a new social and economic organizational period where changes and developments with continuous learning and information acquisition seem inevitable, the structures of school and learning environments change as well [5]. Schools as educational institutions should be multifunctional places where knowledge is produced, used and developed, and should be open to development. They should provide an environment that provides security to humans and team work. They should be open to the public for 24 hours and should satisfy new knowledge needs of the society [6].

Knowledge management is an organizational process where organizational goals are realized with the contributions of people's efficiencies, experiences and thoughts [7]. In other words, it is the determination and use of the shared knowledge that is

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 67–75, 2013.

developed by the organization's own experiences and skills [8]. The schools that utilize knowledge management enlarge their capacities to reach results they aim for and adopt a new style with enthusiasm by knowing how to learn together [9].

Teachers, who are the most important components of the educational organization, have their values, beliefs and assumptions about both teaching and school education and the teaching profession prior to starting teaching. In their daily school experiences, they acquire new knowledge, experience and work practices, and new thinking methods about their schools. They acquire experiences and new knowledge and skills when they interact with other people both inside and outside the school [10].

Today, if schools, which are the source of knowledge, adopt knowledge management, they can realize major functions such as directing development and change. Education is an industry of people, and schools are organizations that depend on knowledge. Motivated by these facts, knowledge management is defined as an organization's power of creating values from abstract and real values [11]. The teachers' professional knowledge is the school's most important value that is abstract but at the same time real. Management of teachers' professional knowledge in the field of education is the subject of knowledge management [12]. In the study conducted by Celep and Değirmenci [13] teachers stated that school administrators (managers) in schools in Turkey usually supported knowledge sharing and new knowledge production but they were not in touch with out-of-school resources. In this context, the realization of knowledge management practices in educational organizations and the addressing of problems about the current situation would require further attention. Motivated from this gap in the literature, this study aims to identify the opinions of teachers who are working in primary, secondary and high schools in the city of Kocaeli in the county of Izmit about the knowledge management process in schools. The main question of the study was: "What are the opinions of teachers in primary, secondary and high schools about the knowledge management process in schools?"

The following sub-questions were examined to answer the main question:

1. Is there any significant difference in the opinions of the teachers about the knowledge management process according to their gender?
2. Is there any significant difference about the opinions of the teachers about the knowledge management process according to their age?
3. Is there any significant difference about the opinions of the teachers about the knowledge management process according to their years in service?

2 Methodology

2.1 Research Design and Data Collection

The research model used in this study was a survey. The Knowledge Management Process in Schools Scale was used to identify the level of perceptions of the teachers about knowledge management in schools.

The population of the study was teachers who were working in primary, secondary and high schools in Kocaeli, Izmit. The sample of the study was 270 teachers that were randomly selected from 5 primary and 2 secondary schools in Kocaeli.

The data collection tools were developed and based on expert opinions cited in the previous literature by the researchers. The questionnaire included questions about knowledge management in the schools in which the teachers were working. A pool of questions about knowledge management was compiled with the help of previous literature. In the third part of the survey participants were asked 4 questions about the knowledge management process, rating their answers from 1 to 5: "In your opinion, what is the degree of openness of the teachers in your school about renewing themselves professionally?"; "In your opinion, what is the degree of openness of the teachers in your school about being criticised professionally?"; "In your opinion, what is the level of using traditional solution methods when the teachers in your school encounter a problem?"; and "How open are you to share your professional knowledge about teaching with your colleagues?"

2.2 Developing the Scale

In developing the scale, the researchers reviewed the previous literature and compiled a pool of questions of 65 items. Likert-type scales were used to measure the teachers' opinions about the knowledge management process. In the scale, 1 referred to 'absolutely disagree', 2 to 'disagree', 3 to 'no opinion', 4 to 'agree', and 5 to 'absolutely agree'. The Kaiser-Meyer-Olkin (KMO) Sample Proficiency Test and the Barlet Global Test were used to test the suitability of the data's factor analyses with the Knowledge Management in Schools Teacher Scale. The KMO value was over 0.60 and the Barlett test showed a 0.05 significance value. Both of these results demonstrated that the data set was suitable for factor analyses (KMO=0.911, $\chi 2$ Barlett test= 12364.652, p=0.000). When 65 items of the scale were analysed according to the factor analyses, 25 of them were removed from the scale either because they carried high load values in more than one factor or their factor load value was lower than 0.30. The remaining 40 items showed self-values higher than 1. These were grouped into 6 factors.

The factor loads of the different categories were as follows: obtaining knowledge was between 0.811 and 0.514; using knowledge was between 0.768 and 0.516; learning knowledge was between 0.761 and 0.525; evaluating knowledge was between 0.810 and 0.416; and administrative support was between 0.732 and 0.496. The total variance of the six factors was 63.9% and the reliability value of the Knowledge Management Process in Schools Scale was $\propto$=0.96.

The arithmetic mean, standard deviation, variance and reliability values of the Knowledge Management Process in Schools Scale are provided in Table 1. When we analyze Table 1, we can see that the dimension with the highest mean is administrative support and the dimension with the lowest mean is evaluating knowledge.

Table 1. Arithmetic Mean, Standard Deviation, Variance and Reliability Values of the Knowledge Management Process in Schools Scale

Dimensions	Item Numbers	$\overline{X}$	sd	Variance	Reliability Value
Administrative Support	15,16,13,17,14,28	3.98	.760	5.12	.89
Obtaining Knowledge	21,19,20,22,18	3.77	.804	4.33	.92
Using Knowledge	65,63,62,64,61,58,57	3.75	.779	3.46	.85
Sharing Knowledge	4,5,1,3,10,7,6,2	3.69	.818	40.61	.90
Learning Knowledge	44,43,41,42,36,45,38,9	3.52	.827	7.06	.90
Evaluating Knowledge	25,31,23,24,29	3.33	.899	3.26	.82

These facts would indicate that the teachers have more positive opinions about administrative support in the knowledge management process and there are some problems about the evaluation of knowledge.

3 Findings

Some 89% of the participants in the study stated that they had an email address, 12% owned a website, 85% stated that their schools had a website and only 23% of the participants stated that they read professional magazines, journals or books regularly.

To the question "In your opinion, what is the degree of openness of the teachers in your school about renewing themselves professionally?" the participants on average stated that the level of openness was $\overline{X}$=3.25, 1 being not open and 5 being very open. This finding would indicate that the teachers felt that their colleagues were quite open to renew themselves professionally. However, their answer to the question "In your opinion, what is the degree of openness of the teachers in your school about being criticised professionally?" provided a lower average of $\overline{X}$=2.85. Moreover, the average to the question "In your opinion, what is the level of using traditional solution methods when the teachers in your school encounter a problem?" was $\overline{X}$=3.20, and the question "How open are you to share your professional knowledge about teaching with your colleagues?" yielded an even higher average score of $\overline{X}$=4.04. As a result, one can infer that the teachers in this study were open to share knowledge with their colleagues and were inclined to develop themselves professionally; however, they were still using traditional methods to solve their problems and they did not read professional magazines, journals and books regularly.

When the opinions of the teachers about the knowledge management process was examined, the items "Our principal would finish work that he started" ($\overline{X}$ =4.21), "Our principal would keep his promise" ($\overline{X}$ =4.17), "Our principal has the necessary proficiency that his position requires" ($\overline{X}$ =4.11) had the highest averages. These facts would indicate the value of administrative support in the knowledge management process. On the other hand, items such as "Special situations such as tea hours and informal discussion settings to discuss personal and professional problems are created in our school for teachers to share and interact informally" ($\overline{X}$ =2.94) and "Our teachers' success is symbolically rewarded" ($\overline{X}$ =2.98) had the lowest averages.

A T-test was utilized to evaluate the opinions of teachers about the knowledge management process in schools based on their gender. The results of the analyses are provided in Table 2. According to these analyses, male teachers had higher averages about learning knowledge ($\overline{X}$ =3.64) and evaluating knowledge ($\overline{X}$ =3.48) compared to female teachers, ($\overline{X}$ =3.38) and ($\overline{X}$ =3.17) respectively. Our analyses also revealed that these differences were significant (t (270) =-2.640, p<.05; t (270) = 2.922, p<.05).

Table 2. T-test Results about the Knowledge Management Process in Schools based on Gender

Dimensions	Gender	n	$\overline{X}$	sd	df	t	p
Obtaining	Female	135	3.73	.788	275	.729	.466
Knowledge	Male	135	3.80	.824			
Using	Female	135	3.67	.796	275	.146	.145
Knowledge	Male	142	3.81	.764		0	
Learning	Female	135	3.38	.836	275	.266	.008**
Knowledge	Male	142	3.64	.806		2	
Sharing	Female	135	3.65	.844	275	.905	.366
Knowledge	Male	142	3.74	.791			
Evaluating	Female	135	3.17	.900	275	.291	.004**
Knowledge	Male	142	3.48	.881	275	6	
Administrative	Female	135	3.94	.704	275	.928	.354
Support	Male	135	4.02	.812	275		

Note: **p<.01; *p<.05.

The results of the questionnaire in terms of the participants' opinions about the knowledge management process based on gender revealed that male teachers had more positive opinions about learning knowledge and evaluating it compared to female teachers.

To compare the participants' opinions about knowledge management process based on the ages of the teachers, an ANOVA test was used. The results of the analysis are given in Table 3.

The results of the analyses revealed that the teachers' opinions about the knowledge management process in schools differed significantly according to their ages (F(7-270)=2.462, p<.05).

Table 3. ANOVA Results about the Knowledge Management Process in Schools based on Age

Dimensions		Total Square	df	Average of Squares	F	p
Obtaining Knowledge	Among Groups	6.704	4	1.676	2.652	.034*
	Within Groups	171.24	271	.632		
	Total	177.95	275			
Using Knowledge	Among Groups	3.265	4	.816	1.351	.251
	Within Groups	163.72	271	.604		
	Total	166,99	275			
Learning Knowledge	Among Groups	.398	4	.099	.143	.966
	Within Groups	187.35	270	.694		
	Total	187.75	274			
Sharing Knowledge	Among Groups	3.471	4	.868	1.302	.270
	Within Groups	180.60	271	.666		
	Total	184.07	275			
Evaluating Knowledge	Among Groups	1.367	4	.342	.419	.795
	Within Groups	222.12	272	.817		
	Total	223.49	276			
Administrative Support	Among Groups	2.564	4	.641	1.111	.352
	Within Groups	155.76	270	.577		
	Total	158.33	274			

Note: **p<.01; *p<.05.

To determine the source of the difference, a Tukey test was administered. The results of the Tukey test are given in Table 4.

Table 4. Tukey Test Results about the Knowledge Management Process in Schools based on Age

Dimensions	(I) Age	(J) Age	(I-J) Mean Difference	Sh	p
Obtaining Knowledge	20-30	31-40	-.02602	.11333	.999
		41-50	.17083	.14447	.761
		51-60	-.10476	.19441	.983
		61 and older	1.60000	.56891	.042*
	31-40	20-30	.02602	.11333	.999
		41-50	.19685	.13529	.593
		51-60	-.07875	.18769	.993
		61 and older	1.62602	.56665	.036*

Note: **p<.01; *p<.05.

To compare the participants' opinions about the knowledge management process based on years in the service, an ANOVA analysis was used. The results of the analysis are given in Table 5.

Table 5. ANOVA Results about the Knowledge Management Process in Schools based on Years in Service

Dimensions		Total Squares	df	Average of Squares	F	p
Obtaining Knowledge	Among Groups	2.188	7	.438	.672	.645
	Within Groups	175.762	270	.651		
	Total	177.950	277			
Using Knowledge	Among Groups	2.903	7	.581	.955	.446
	Within Groups	164.090	270	.608		
	Total	166.992	277			
Learning Knowledge	Among Groups	.513	7	.103	.147	.981
	Within Groups	187.242	270	.696		
	Total	187.754	277			
Sharing Knowledge	Among Groups	3.922	7	.784	1.176	.321
	Within Groups	180.149	270	.667		
	Total	184.071	277			
Evaluating Knowledge	Among Groups	6.490	7	1.298	1.621	.155
	Within Groups	217.002	270	.801		
	Total	223.492	277			
Administrative Support	Among Groups	6.930	7	1.386		
	Within Groups	151.401	270	.563	2.462	.033*
	Total	158.331	77			

Note: **p<.01; *p<.05.

Based on the results of the analyses, there was a significant difference concerning administrative support in the knowledge management process ($F(7\text{-}270)=2.462$, $p<.05$). However, there was no significant difference about obtaining knowledge ($F(7\text{-}270)=.672$, $p>.05$); using knowledge ($F(7\text{-}270)=.955$, $p>.05$); learning knowledge ($F(7\text{-}270)=.147$, $p<.05$); sharing knowledge ($F(7\text{-}270)=1.176$, $p>.05$); or evaluating knowledge ($F(7\text{-}270)=1.621$, $p>.05$) compared to administrative support.

To determine the source of the difference about teachers' opinions about the knowledge management process based on years of service, a Tukey test was administered. The results of the Tukey test are given in Table 6.

Based on the Tukey test results, the teachers with 26 or more years in service had more positive opinions about the knowledge management process compared to teachers with years in service between 21 and 26. This would show that teachers with 26 or more years in service are more inclined to support, and had higher trust in terms of principals' actions and thoughts. Based on Celep and Değirmenci's (2005) study, teachers between the ages of 41 and 50 had more trust about the knowledge management process compared to others. In this context, one can argue that age and years in service would have some effect on the knowledge management process.

Table 6. Tukey Test Results about the Knowledge Management Process in Schools based on Years in Service

Dimensions	(I) Age	(J) Age	(I-J) Mean Difference	Sh	P
Administrative Support	26 and more	1-5 years	.28054	.20709	.754
		6-10 years	.19712	.20937	.935
		11-15 years	.53725	.20906	.108
		16-20 years	.49530	.23094	.268
		21-25 years	1.24306	.54213	.046*

Note: **p<.01; *p<.05.

4 Results and Discussion

Knowledge management is a relatively young but increasingly popular field of organisational study [14]. A pertinent definition is: "the process of identifying, capturing, organizing and disseminating the intellectual assets that are critical to the organisation's long-term performance" [15]. Sallis and Jones [14] claim that many corporate institutions do not have a specific strategy for knowledge management, and "of the few that do have such a strategy, almost none are in the education sector" (p. 63). While the concept of knowledge management has been examined extensively within the business context, very little is known about how the knowledge management process may benefit educational institutions [16].

School knowledge management is involved in the process of knowledge acquisition, accumulation, sharing, transformation, application, innovation, integration and diffusion, which is impacted by school leadership, organizational culture, information technologies, performance management, and other enablers [17]. The results of this study revealed that even though the teachers were open to renew themselves professionally through a knowledge management process, they are still using traditional methods to solve their problems. Moreover, administrative support plays a facilitative role in the knowledge management process, but the reward system is not satisfactory. The opinions of the teachers about the knowledge management process was analyzed on their gender and it was found that the male teachers had more positive opinions about the knowledge management process compared to female teachers. Another point of interest from this study was the years in service for the teachers, and the findings that teachers between the age groups of 20 to 30 and 31 to 40 had more positive opinions about obtaining knowledge compared teachers who were 61 or over at the time of the study. When years in service was examined, the findings revealed that teachers with 26 years or more in service had more positive opinions about administrative support compared to their colleagues with different years in service. This would imply a greater trust from more experienced teachers towards the administration.

When the opinions of the teachers are interpreted about the knowledge management process as a whole, the teachers highlighted the importance of administrative support. Male teachers and teachers under the age of 40 had positive opinions about

the knowledge management process particularly. To address problems that the study revealed, one can support teachers who are older than their colleagues about obtaining knowledge and increase activities that might help female teachers join the knowledge management process. Moreover, to have a more effective knowledge management process, some informal meetings could be organized and teachers taking part in these meetings could be rewarded to change their opinions to make them more positive.

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Knowledge Management in University Administration in Malaysia

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Abstract. Knowledge management is important to both business and government organisations as a means of improving their operations. This research project investigated cultural factors affecting knowledge management in higher education administrative departments in Malaysia. It considered strategic decisions made by university administrations and adoption decisions made by individual staff members. As the study was conducted in the South-East Asia region, organisational culture in this region is important. The paper describes the factors found to affect the practice of knowledge management in higher education in Malaysia.

Keywords: Knowledge management practices, organisational culture, Malaysia, higher education administration.

1 Introduction

The use of Knowledge management practices is widely considered to be a way to enhance organisational performance in business, government and other organisations. The research project described in this paper investigated cultural factors affecting knowledge management in higher education administrative departments in Malaysia. The concept of knowledge management is not new, and has been well known in Malaysia for over a decade, but in Malaysia the use of knowledge management techniques must be considered to be still in the developmental stage.

This paper investigates the strategies and innovation factors behind all these adoption decisions – strategic decisions made by the university administration and adoption decisions made by individual staff members. Following the university adoption decisions, we will consider whether complete adoption of this technology by individual administrators necessarily follows.

2 Knowledge Management: Data, Information and Knowledge

Most authors in the knowledge management literature define knowledge by differentiating it in meaning from data and information. Data widely refers to the raw

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 76–85, 2013.

facts and numbers [1, 2], while information is looked upon as data put into context or processed data [1, 3] that can reside within computers. Bhatt [2] regards knowledge as an organised set of data – information that is combined with experience and judgment will then become knowledge.

Knowledge is authenticated information [1] and refers to the understanding, awareness or familiarity acquired through study, investigation, observation or experience over time [3] and acts as a basic foundation of the information a person needs to perform a task [4]. According to Alavi and Leidner [1] knowledge is also personalised information that is related to facts, procedures, concepts, interpretations, ideas, observation and judgment that is possessed in the mind of individuals. McMurray [5] defines knowledge as the mixture of experience, values, expert and contextual information that helps the people or organisation in the evolution and absorption of new experience.

Knowledge is rooted in philosophy, which traditionally distinguishes three types of knowledge: 'knowing how' refers to the skills one develops and, most of the time, is tacit in nature; 'knowing that' resembles information since it is de-contextualised; and 'knowing things' refers to the knowledge of acquaintance [6]. Knowledge is also categorised as declarative, procedural, causal, conditional and relational knowledge [1]. However, the most commonly used taxonomies in literature are Polanyi's [7, 8] and Nonaka's [9] dimensions of tacit and explicit knowledge. Nonaka [9] and Nonaka and Takeuchi [10] argued that knowledge is created through conversion between tacit and explicit knowledge through the process of socialisation, externalisation, internalisation and combination. This knowledge concept comprises epistemological and ontological dimensions.

In organisations, knowledge resides in many different places such as databases, knowledge bases, filing cabinets and people's heads and is distributed right across the enterprise. Too often one part of an enterprise repeats work of another part simply because it is impossible to keep track of, and make use of, knowledge in other parts of the organisation. Organisations need to know what their knowledge assets are, and how to manage and make use of these assets in order to get a maximum return. This is where knowledge management concepts play an important role in organisations.

Two types of knowledge are involved in higher educational settings: academic knowledge and organisational knowledge. Academic knowledge is the primary purpose of higher education, while organisational knowledge refers to knowledge of the overall business of an institution, its strength and weaknesses, the market it serves and the factors critical to organisational success [11].

Knowledge management (KM) concepts are gaining acceptance in the field of education [12]. As in business concerns, Higher Education Institutions (HEI) have also realised the need to gain competitive advantage due to stiff competition and pressure to face globalisation. With the growing interest of KM in education, numerous studies have been conducted to examine KM issues in a wider context. Research in KM implementation for HEI has just recently attracted the attention of researchers [13], and has been rather limited especially in the South-East Asian region [14, 15]

A study conducted by Davenport et al. [16] identified four types of objectives for knowledge management practices in organisations. These objectives have been

widely referred to in the literature of KM implementation for higher education such as in Thorn [17]. They are:

- To create knowledge repositories.
- To improve knowledge access.
- To enhance the knowledge environment.
- To manage knowledge as an asset.

2.1 Organisational Culture

Organisational culture has been identified as a critical success factor for knowledge management, however, there is little research conducted to understand how organisational culture contributes to knowledge management practices. Hofstede [18] argues that the organisation's culture is nested within a national culture and therefore the national culture influences human resource practices and organisational behaviour. However, studies by Magnier-Watanabe and Senoo [19] show that organisational characteristics are factors that affect knowledge management practices in organisations more strongly than national culture. Based on this argument, the focus of this research was on the culture from an organisational characteristics perspective and not in terms of the national culture.

This study was conducted in the South-East Asia region and organisational culture in this region is important. Countries' independence from British rule is often marked by a passive management culture borrowed from the British colonial era [20] and public sector organisations of these countries are often bureaucratic, centralised and non-responsive to customer need.

2.2 Innovation in Knowledge Management

Innovation can be described as a pervasive attitude that allows business to see beyond the present and create the future and therefore becomes the key driver of the organization's ability to change [21]. In this context it is important to understand what is meant by innovativeness and the innovative culture of an organization. Firm innovativeness is defined as an openness to new ideas as an aspect of a firm's culture [22]. It is conceptualised from two perspectives:

1) viewing it as a behavioural variable, which refers to the rate of adoption of innovations by the firm; and
2) viewing it as an organization's willingness to change [23]. It is also important that a creative environment backs up the organizational attitude and takes actions people are comfortable with [21], which constitute the cultural element of the organization.

2.3 Knowledge Management in Higher Education

Knowledge management is still considered in its infancy in Malaysia [24]. Studies conducted in the area of Higher Education in Malaysia are sparse. This research narrows down to the organisational cultural aspects and intends to investigate the

adoption of knowledge management practices in higher educational administrative departments from the perspective of organisational culture, so it is important to understand the unique culture of an academic environment.

3 Conceptual Framework

Many studies have linked organizational cultures as a pre-requisite for effective knowledge management. Scholars and practitioners believe that supportive and adaptive organizational culture enables the successful implementation of knowledge management practices in organizations [25]. This paper studies the extent to which the cultural factors in organizations affect their knowledge management practices. Based on the literature, this study adopts a conceptual framework involving the following seven cultural factors (see Figure 1):

1. Willingness to share knowledge.
2. Co-operation amongst organizational members.
3. Involvement and participatory culture which includes open communication channels, encouragement of participation, involvement in decision making and encouragement for sharing information.
4. The need of high-level of trust in organizations and among employees.
5. The need of a culture that encourages problem seeking and solving which will encourage employees to look for problems as a way to improve the organization and to embrace the capacity to learn from failure.
6. Adaptability or capability to absorb internal change in response to external conditions.
7. Sense of mission and vision which influences the organization by providing purpose and meaning as to why the work is important, and defines the appropriate course of action for the organization and its members.

4 Research Methodology

This study used a mixed methods research approach. In the qualitative phase, interviews were conducted with participants from higher education administration in five Malaysian universities. From these, and from studies from the literature, a conceptual model was developed to show the effect of cultural factors on knowledge management practices in higher education administration: knowledge sharing; cooperation, involvement and participation; trust; problem seeking and solving; adaptability to change; and sense of vision and mission. The quantitative phase then used questionnaires distributed to university administrative staff and managers to investigate how these factors affect each other and how they affect KM implementation.

The data collected from the key informant interviews conducted has been transcribed and analysed using content analysis and categorisation processes to bring to the surface the culture elements or areas discussed during the interviews. The results

from this analysis were used to develop web-based questionnaires to be used for the second phase of the study. The second phase of data collection (quantitative data) started by sending emails to the administrative staff and managers from the chosen HEI requesting their participation in the survey. The data collected from the web-based questionnaires was then analysed using the Partial Least Square (PLS) method and PLS software to test and estimate causal relationships using a combination of statistical data and qualitative causal assumptions.

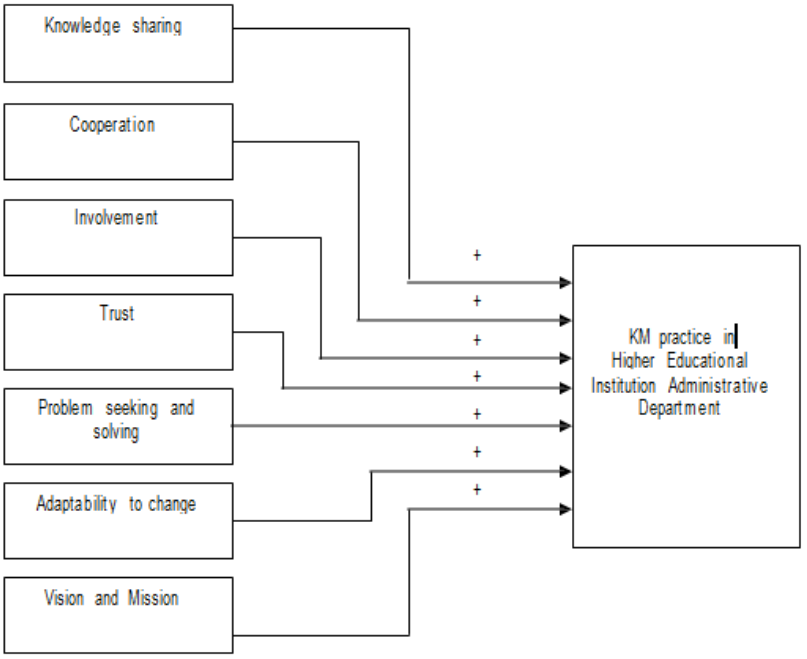

Fig. 1. Conceptual framework to study the effect of cultural factors on KM practice in HEI administrative departments

The following were the research questions:

- What is the perception of administrative managers and staff in Malaysian public universities on viewing KM as an innovation?
- What is the state of KM implementation in the administrative departments of the public universities in Malaysia?
- Are cultural factors such as knowledge sharing culture, cooperative culture, involvement and participation culture, trust culture, problem seeking and solving culture, adaptability to change culture, and the sense of vision and mission perceived as affecting KM practices in the administrative department of the public universities in Malaysia?
- Do these cultural factors affect the KM practices in the administrative departments of the public universities in Malaysia?

5 Research Findings

Out of 20 public universities in Malaysia, 6 universities are included in the qualitative study phase, and 10 universities are included in the quantitative study phase. A total of 22 respondents were contacted for the interview sessions with 12 agreeing and providing useful answers (54.5%). The data collection for the quantitative stage took place over 2 months and participant lists were obtained directly from the university's human resource department. A total of 1,000 participants were contacted, resulting in 351 useful responses (35.1%). Three hundred and sixteen participants answered the Bahasa Malaysia survey, while 35 participants answered the English survey.

5.1 Findings from the Qualitative Study

Knowledge Management Practices in Malaysian HEI Administrative Departments: Respondents viewed KM implementation as a way to manage organisational knowledge in order to achieve business excellence. Most commented that the knowledge management practices in their administrative departments are in the developmental stage with a lot of opportunities for improvement. As one respondent said:

> *"… later data can be retrieved for the right purpose, at the right time and for the right source …"*

Behaviour and Support towards Knowledge Management as an Innovation: Findings from the interviews reveal that three out of five universities have already been implementing knowledge management for quite some time and are in the stage of strengthening their practices. On the other hand, the findings from one university showed that their staff are unaware of the existence of such practice. One respondent indicated that "*knowledge management is a difficult new thing*".

Knowledge Sharing Culture: Knowledge sharing culture does exist in university administrative departments but it was stated by some respondents that this culture only occurs among staff within the same group level and the same department. This is particularly true when dealing with tacit knowledge or staff experiences of knowledge in performing jobs specific to their expertise. Partial knowledge-sharing does occurs in these institutions and some individuals also engage in knowledge sharing to the extent that they believe it will be beneficial for them to do so, and that it will not damage their reputation. A typical response was that:

> *"I see that everyone is busy doing their own work and did not bother about other people. Sometimes we don't really know what's going on in the campus …"*

Co-operative Culture: Co-operation ranges from moderate to good among administrative staff in Malaysian universities, but one respondent commented that: *"It depends on individuals: some people are not willing to cooperate with others."* In dealing with cooperation, the majority of the respondents commented on the

importance of the leadership role needed to make cooperation happen. One said that it "*… depends on the leaders who head the particular tasks*". Another also commented that staff are willing to co-operate with people who are willing to co-operate with them: "*given a fair opportunity"*. Factors encouraging staff to cooperate include:

- Their understanding of the subject matter.
- Belief that others need to know what they know.
- Their sense of belonging to the unit or department.
- Reward factors.
- Relationships among staff.
- Encouragement based on leader attitude.

Involvement and Participation Culture: Results from the interviews on involvement and participation culture led to the following observations:

- Some staff regard the involvement and participation culture in their university as being good, with the existence of various tools for staff to participate.
- The involvement and participation culture varies according to staff motivation.
- The involvement and participation culture depends on the leader – whether this person is open minded and willing to accept suggestions from lower-level staff.

Trust Culture. The majority of the respondents rated trust culture in HEI administrative departments as good to high. One of the respondents also noted that willingness to help others depended on the social relationship with these people. Two of the respondents also related trust with cooperation: "*… trust and cooperation come together*" and "*… trust leads to cooperation among staff*".

Problem Seeking and Solving Culture: It was observed that problem solving cultures do exist in the administrative departments of Malaysian universities and that: *"… post mortem, root cause analysis does exist …*" and that "*… there is a system here … where people will meet in order to find solutions for some kind of problems that arise … whoever can come out with the solution will be rewarded [by the university].*"

Adaptability to Change: Comfort or familiarity with what people already practice may be a factor in people's reluctance to change. In most situations management has to make some practice or implementation compulsory in order to make people change their current practice or adopt a new one.

Sense of Vision and Mission: Results from the interviews showed that administrative staff in Malaysian universities are aware of their institutions' vision and mission. However, it was observed that staff support toward the organisational vision and mission varies.

Other Emerging Factors:

- **Leadership**. Throughout the interviews comments on leadership issues arose from participants in each university involved in this study. One respondent said: "*What makes people contribute, I think is the administrator. I always believe that the leader is the most important person.*"
- **Technology.** It was observed that at the beginning of the interview sessions most respondents linked their understanding of knowledge management practices with the existing technologies they have available for storing and retrieving information and knowledge. Comments included:

> *"I think culture has to be supported by the technology. People must practice knowledge management through technology … Culture alone is not enough, especially in our traditional culture … I think, since our university is technology oriented, that is what makes our movement towards knowledge management is faster compared to other university."*

- **Language.** The majority of public university staff in Malaysia are Malay and are using Bahasa Malaysia as their medium of communication. There were a few respondents who indicated that language became a barrier for staff to support knowledge management. The most common statement was that language became a barrier to communication and a barrier to understanding.
- **Religion.** Interview findings showed that few respondents associate the necessity to share and distribute knowledge in their organisation with religious factors. Since most Malaysian public universities staff are Malays whose religion is Islam, they relate existing practices with their religion. A few respondents indicated that knowledge is a fundamental principle of Islam and added that distributing and sharing knowledge is a good deed promoted by their religion and that the act of storytelling was also demonstrated in their religion.

5.2 Findings from the Quantitative Study

The result from the PLS analysis revealed relational details about the seven factors investigated: knowledge sharing, cooperation, problem seeking and solving, involvement and participation, trust, adaptability to change, and, vision and mission do not directly influence knowledge management practices in higher educational administration in Malaysia. Space restrictions mean that it is not possible in this paper to give full details of the results of the qualitative study, but it was shown that the following factors do affect each other in knowledge management implementation:

- That involvement and participation affect knowledge sharing in higher education administration.
- That involvement and participation affect problem seeking and solving in higher education administration.
- That trust affects adaptability to change in higher education administration.
- That trust affects cooperation in higher education administration.

- That vision and mission affect trust in higher education administration.
- That vision and mission affect cooperation in higher education administration.
- That co-operation affects knowledge sharing in higher education administration.

6 Conclusion

The study shows that the seven indicated factors: knowledge sharing, cooperation, involvement, adaptability to change, trust, problem seeking and solving, and vision and mission do not have a direct impact on KM practice in university administration in Malaysia, but that some factors do affect one another. The research suggests that leadership and available technology are the most important concerns of the participants when knowledge management practice is discussed, and that language and religions might also have an effect on KM practice in Malaysia. It is also interesting to see that reward factors, which were indicated as one of the factors that might affect KM practices, were found in this study not to be a reliable measure. This research was confined to Malaysian universities but this then opens up more possibilities for future research on knowledge management implementation in higher educational administration in other countries.

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Socio-technical Gaps Exposed by the United States Department of Education's Teacher Incentive Fund Grant Program

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Abstract. The United States (U.S.) Department of Education's Teacher Incentive Fund provides financial support for local school districts, state agencies, and non-governmental agencies to design and implement performance-based compensation systems that reward teachers and leaders who improve student learning. These policies put pressure on data systems and the social systems of supporting organizations to adapt tools and procedures designed for administration and scheduling to deliver high-stakes outcome results. This misfit has led to system failure in some early implementations. It has also led to the development of new technical solutions and unlikely partnerships between social actors in these spaces.

Keywords: Data quality, performance pay, growth measures, educator effectiveness.

1 The U.S. Teacher Incentive Fund Program

Performance based compensation systems are not new to education. There have been prior attempts to explore and implement such programs – usually referred to as *merit pay* – in the 1970s and 1980s [1]. The notion is a simple one – tying pay (sometimes base pay but often one's bonus) to one or more performance measures. In the case of teachers, this could be measured using a number of different metrics – from improvements in student performance on high stakes tests to assuming additional duties or leadership roles in addition to classroom teaching. This paper will describe the reintroduction of performance pay in the education sector in the United States (U.S.) and the substantial change in requirements for technical systems, for analytical skills of teachers and administrators, and for collaboration across traditional organizational boundaries.

While there has been on-going experimentation in evaluating and compensating teachers since the 1980s, there was no large scale implementation of such policies until the creation of the Teacher Incentive Fund. The Teacher Incentive Fund (TIF) program was created in 2006 [2] as a competitive grant program administered by the U.S. Department of Education that was intended to allow schools, school districts, state agencies, and non-governmental partners to design and implement performance-based compensation programs. There were two rounds of grants made under the

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 86–93, 2013.

original funding. The appropriation was allocated in two rounds of grants. The first, referred to the by the Department of Education as Cohort 1, received a total of $42 million awarded across 15 grantees in November 2006. The second group of 18 recipients – referred to as Cohort 2 – received $38 million in June 2007 [3]. There was a third round funding announced in May 2010 [4] and awards made in September 2010. The third round of TIF grants - Cohort 3 – were made from an appropriation of $437 million. The grants were awarded to 62 recipients – 50 grantees in the general program and 12 grantees who also agreed to participate in a randomized, controlled trial of their designed program against a simple whole-school bonus treatment [5]. The focus of this program is stated in the press release announcing the most recent call for proposals as follows, "TIF grants support local projects that reward teachers, principals and other school personnel who improve student achievement [6]." This basic notion has been operationalized differently across the three rounds of funding. Changes to the program requirements for Cohort 3 reflect a substantial shift from a reliance on compensation alone to a set of measures and interventions designed to achieve the desired core policy goal of improving outcomes for students.

The TIF focus on improving student outcomes – particularly the focus on growth in student learning – has led to a change in data needed to meet the requirements, the quality of that new and pre-existing data, timeliness of data reporting and quality assurance/verification around the use of those data. Data that had been collected and managed for student scheduling, payroll, etc. suddenly needed to reflect new relationships and radically higher-stakes use cases. In addition to their reliance on test-based measures of student progress, all TIF grantees are also implementing observational frameworks based on detailed rubrics to evaluate, score, and share evaluations of teacher and principal practice.

In this paper, I will focus on the grant priorities articulated in the 2010 request for TIF proposals (mentioned above). I will explore the socio-technical implications for implementing these reforms we have discovered while providing technical assistance to the U.S. Department of Education (U.S. ED) and the nearly 100 TIF grantees funded to date. In particular, I will explore the very detailed workshop materials from a presentation made by U.S. ED staff on June 3, 2010. Senior program and policy leaders from the Department held a Technical Assistance Workshop for any organizations considering applying for a Teacher Incentive Fund [7]. The workshop covered eligibility for the program and incentives for a subgroup to participate in a formal evaluation. The primary focus of the presentation was on the absolute and competitive priorities of the competition and how proposals would be evaluated based on the quality with which the grantees addressed these priorities.

TIF program managers at U.S. ED had engaged with the technical assistance providers and major national actors (reform groups, labor unions, etc.) to create more explicit grant priorities for Cohort 3. They also translated the priorities into what they called the Core Elements of the TIF program and stated that they would require all grantees to adequately implement these program features in their TIF projects [4]. The Core Elements provide the primary measurement framework for the required Annual Performance Report (APR) each grantee must submit. The APR also requires all grantees to set goals on all performance based on actual first year performance. Seen as

compliance measures, the Core Elements are indicators of the presence of required program features. At the same time, they also provide a framework for understanding the level or success of program implementation.

2 Core Elements

As stated above, the Core Elements provide the bulk of the program measures for each TIF grantee (in addition to financial review for compliance with spending rules). Each of the core elements has implications for information and communications systems. I explore how some of these requirements have translated into very real challenges for many TIF grantees.

2.1 Core Element A

> *A plan for effectively communicating to teachers, administrators, other school personnel, and the community-at-large the components of its [performance-based compensation systems] PBCS [4]*

In the initial two TIF Cohorts, many grantees had no or very limited communication plans. The requirements for Cohort 3 include the development of an initial plan that identifies all stakeholders and then builds tailored communication channels and strategies to carry the project through its full lifecycle. Grantees are required to engage in on-going communication activities and have strategies in place for communicating changes to the program. Some of the larger grantees developed social media sites and many used role-specific outreach materials to target school staff, parents, and the community at large (see, for example [8]). Grantees now routinely include allocation of funds for hiring communication consultants to help guide the development and implementation of their plans.

The most challenging implications for technical systems in this Core Element are the growing importance of two-way communication in any *social* media channel. One of the most common approaches to two-way communication is the collection of questions (including online submissions, systematic notes taken from face-to-face presentations, etc.) that are then answered in a *Frequently Asked Questions* resource (see [9]). As school districts and schools integrate interactive communication channels into their communication strategies, the expectations of participants in the system for timeliness and transparence will very likely also go up.

2.2 Core Element B

> *The involvement and support of teachers, principals, and other personnel (including input from teachers, principals, and other personnel in the schools and LEAs to be served by the grant) and the involvement and support of unions in participating LEAs (where they are the designated exclusive representatives for the purpose of collective bargaining) that is needed to carry out the grant [4]*

This is the only Core Element that does not explicitly have a technology component. However, beyond the initial agreement to participate in the project, most projects consider the active components of the communication plan as a portion of the evidence of compliance with Core Element B. Involvement usually includes email newsletters, websites, webinars, etc. that communicate the on-going development of the various aspects of the project and convey what role the participation of represented staff members have made by showcasing teacher involvement on specific projects or products.

2.3 Core Element C

> *Rigorous, transparent, and fair evaluation systems for teachers and principals that differentiate effectiveness using multiple rating categories that take into account student growth ... as a significant factor, as well as classroom observations conducted at least twice during the school year. The evaluation process must: (1) Use an objective, evidence-based rubric aligned with professional teaching or leadership standards and the LEA's coherent and integrated approach to strengthening the educator workforce; (2) provide for observations of each teacher or principal at least twice during the school year by individuals (who may include peer reviewers) who are provided specialized training; (3) incorporate the collection and evaluation of additional forms of evidence; and (4) ensure a high degree of inter-rater reliability… [4]*

These four factors of a "[r]igorous, transparent, and fair" evaluation process require substantial infrastructure that is often not present in existing IT systems or actively supported by the local educational agency. Some of the concepts or practices (such as inter-rater reliability on observational measures) are quite foreign to district or school staff members.

The first requirement – a standards-aligned, objective, evidence-based rubric – is something that often does exist as a functional, embedded practice in many schools. There is a substantial research base around approaches to measuring teacher practice. There are several excellent pieces that provide a discussion of comprehensive approaches to teacher evaluation [10-12]. The Bill and Melinda Gates Foundation funded project *Measures of Effective Teaching* is in the midst of conducting a large-scale study of several popular evaluation frameworks (see [13] for a description of the launch of the project and [14] for methods of combining value-added outcomes with observational measures and student surveys).

What many larger districts find difficult about the implementation of this required element is the challenge of collecting, managing, and using this information at scale – across schools, taking adult mobility into account, shaping observation to reflect a teacher at different stages of his or her career, how frameworks should differ by subject and grade level, etc. The National Institute for Excellence in Teaching (NIET) has one of the longest track records of managing these complex data across multiple sites [11]. Their system – called the CODE (Comprehensive Online Data Entry) system - supports the collection and use of observational evaluation data, tracks inter-rater

reliability of evaluators, and links the observational scores to intervention strategies aligned with each strand of the evaluation framework. Many TIF grantees have struggled to reinvent each aspect of such a system – from creating or adapting an evaluation framework to building and deploying the technical apparatus to collect and share the evaluation results. There is a clear market gap in this area. Many vendors are moving in to respond to this need, but the lack of expertise and clear requirements from the customer (schools, districts, and state agencies) suggests that vendors will likely have to go through a number of iterations to deliver tools at the level of sophistication provided by NIET to its partner schools.

2.4 Core Element D

> *A data-management system...that can link student achievement ... data to teacher and principal payroll and human resources systems [4]*

Linking teachers to students by tested subjects has emerged as the most difficult technical challenge encountered across all TIF grants. The core of the problem is the misfit between the original requirements for student information systems and the new requirements measuring teacher performance using high stakes assessment results [15].

Student information systems (SIS) serve a number of functions. Scheduling has been a primary feature for many years. In the early grades, there is usually a room code and students are assigned to that room based on a number of considerations – classroom balance, number of students possible in that space, contract-based student teacher ratios, etc. In later grades, scheduling is a more complex practice that includes managing the mix of offered, required and elective courses in addition to the above requirements. Many state and district data systems in the U.S. revolve around a term that is used to describe the teacher primarily responsible for a particular classroom or course – "Teacher of Record" [16]. In the period before individual level teacher accountability policies, schools were not required to know exactly who the teacher of record for each room or course was. Scheduling typically happens before instruction begins in a future term (fall term is planned at the end of the spring term, etc.) and is refined once a new school year or term starts. It is not uncommon, therefore, for student scheduling systems to have teachers named "teacher one" or "department chair" in the scheduling system when the new school year starts. Many SISs are not linked to human resource systems directly and may never be updated with the identity of a new teacher after scheduling is finished (see [15] for details on some of the challenges and potential solutions to this very common linkage problem).

Contrast this approach to a high stakes use of assessment data – such as calculating the value-added contribution of a given teacher to a classroom of students - that assumes a perfect match between teacher and assigned students – including tracking the mobility of students in and out of a particular classroom, formal or informal team teaching, the support of second language or special education aides, etc. There have been several high profile failures of the student teacher linkage systems that have led to errors in bonus pay-outs for TIF grantees. The most explosive to date was the

incorrect assignment of student teacher linkages in Houston that led to 99 teachers receiving bonuses based on faulty data. Compounding that data quality error, the district leadership then asked all of the teachers who received the bonus to repay it [17]. This led to the admonition that was shared again and again at TIF meetings and in technical assistance sessions – "Don't be Houston". The case of Houston's data quality failures made clear to most observers that 100% accuracy with 0% error is the only acceptable rate for such high stakes use of teacher effectiveness data.

This new requirement remains a challenge for most, if not all, shipping SIS products. Even with the most modern products that can support attribution of multiple adults providing support to each student in a particular subject, the social organization of work and the burden of keeping the technical system updated remains a challenge. In recent discussions with grantees, the conversation often revolves around how much accuracy is enough. When a student is supported with services from multiple adults in a particular curricular area, what is the smallest measurable unit that one needs to track? This remains an open question. System vendors will need to work with practitioners and evaluators to evaluate the payoff of the choices made about accuracy of complex service provision.

Another important scholarly debate emerged in 2009 that may have implications for linkage systems. Jessie Rothstein [18] argued that students were not assigned to classrooms at random. He showed that non-random assignment called into question the validity of estimates of teacher value-added scores, since students on different growth trajectories might be purposefully assigned to particular teachers. This would obscure the actual productivity of any given teacher. There was a rapid scholarly exchange [19] that showed that this problem could be addressed by using multiple prior test scores for students. One of the important issues highlighted by this debate is that students are not assigned to teachers at random and that these non-random assignments might actually produce optimal outcomes for students and teachers with complimentary characteristics. Prospective (forward-looking) student-teacher assignment shares important characteristics with retrospective student-teacher linkage. One may be able to leverage the same system to support both the pro- and retrospective work.

2.5 Core Element E

> *A plan for ensuring that teachers and principals understand the specific measures of teacher and principal effectiveness included in the PBCS, and receive professional development that enables them to use data generated by these measures to improve their practice [4]*

Finally, the TIF program requires that grantees use the results of teacher and principal effectiveness analysis to target the delivery of professional development resources based on those data. We have seen two systemic challenges associated with this requirement. First, while many schools and districts have previously implemented evaluation systems of some sort, the ability to break down evaluation strands into their sub-components and link those to specific professional development interventions is

beyond the analytical capabilities or, at least, far beyond typical practice for most organizations. Second, TIF grantees have not previously tracked individual teacher professional development choices. This requirement to collect information on linked professional development could also mean that schools and districts must collect information of professional development chosen by teachers using their own funds. This substantially extends the requirements beyond simply tracking district- or school-level professional development offerings towards a more holistic understanding of how life-long-learning interacts with teacher and principal effectiveness.

3 Implications

The requirements of the Teacher Incentive Fund Core Elements have proven to be a challenge for many of the current round of grantees. Any actors trying to implement evaluation systems at a scale above individual schools have found every technical hurdle more or less difficult to overcome. The majority of the current Cohort is only now entering the implementation phase of their projects. While many of these educational organizations have piloted most of the infrastructure required to implement their evaluation frameworks, it is unlikely that all will succeed at scale.

It is also clear that most grantees have far to go to create meaningful links between teacher effectiveness measures and professional development resources that would be a good fit to address any identified challenges. Indeed, this approach seems to be a deficit-focused strategy. Another strategy, not present in any of the TIF requirements, would be to identify those practices associated with the most highly effective teachers and proactively promulgate those practices across all staff.

The successes and failures of the prior two TIF Cohorts were reflected in the Core Elements for Cohort 3. It is very likely that some of the challenges identified here will be taken into consideration when the U.S. Department of Education releases the new Request for Application for TIF Cohort 4 – likely to come in spring 2012. The story of TIF is an emerging one. It is likely to have a profound influence on the requirements for most core technical systems in the U.S. When combined with School Improvement and Race to the Top grants, the impact on the information infrastructure for primary and secondary education and teacher preparation is likely to be far reaching and may lead to substantial shifts in who are important actors in this market.

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Monitoring User Patterns in School Information Systems Using Logfile Analysis

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Abstract. Analyzing user patterns in school information systems can be difficult as several methods (e.g. interviews, surveys, and observations) can be time-consuming. We propose logfile analysis as a method that offers several advantages, primarily non-reactive data capture. With logfiles from a school with over 100 teachers over a seven month period, we try to get a deeper insight about the system's usage and the interactions between users. The results show that three user groups can be identified, classified by the intensity of usage. Network graphs helped us to visualize a complex system and helped us to identify important subjects and categories. Nevertheless, logfiles alone lack in providing information giving deeper insights about uses of the system like user goals and aims.

Keywords: Data mining, web mining, school information systems, logfile analysis.

1 Introduction

School information systems (SIS, see [1]) are increasingly used in schools for teachers to communicate with each other, with pupils and with parents. The systems' functions include resource planning, groupware, budget and decision support. Most research in this field is concentrated on interactions between teachers and pupils. Empirical studies on uses of learning management systems (especially in higher education) have shown interesting results about the teaching and learning process [2, 3].

In contrast, our research focus is the communication between teachers and school management (e.g. the principal). The research project "Mediatized organization worlds in schools: Schools as translocal network organizations", funded by the German Research Foundation, focuses on the communication between school members within school information systems [4]. The central research question goes beyond the assumption of one media logic [5] as it tackles the interdependence between media change and organizational change in one specific social world. The empirical research is based on a triangulation of three methods: participant observation within schools; group discussion with teachers and senior staff; and logfile analysis of school information systems.

This paper will focus on the logfiles of one SIS, used to uncover teachers' behavior within these systems and to discuss the benefits and limits of the method critically.

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 94–103, 2013.

2 Logfile Analysis

Logfiles have their origin in the technical basis of server-based software systems – they provide information, problems or errors about the systems and its applications [6, 7]. Programmers use logfiles also for debugging. The term "logfile" is often associated with webserver logfiles like the Extended Common Logfile Format [8]:

1.2.3.4 - - [25/Aug/2011:12:15:33 +0100] "GET /index.php HTTP/1.1" 200 23578 - "Webbrowser (System etc.)"

1.2.3.4 - - [25/Aug/2011:12:15:47 +0100] "GET /page2.php HTTP/1.1" 200 15789 "http://www.domain.com/index.php" "Webbrowser (System etc.)"

Looking at these fictitious logfiles from a webserver (see above), we can identify the user by her Internet Protocol (IP) (1.2.3.4) and additionally the Browser-Operating System (OS)-combination if multiple users use the same internet connection. If a user is identified, one can track the movement within the site because a second last entry contains the page the user came from, the so-called referer. In the example above, the user enters the site at 'index.php', stays on the site for 14 seconds and moves on to 'page2.php' by using a hyperlink. These "clicks" are called actions. Using this information, we can track movements from all users separately.

Nowadays, marketing [9] and (e-)commerce [10] also use the advantages of analyzing logfiles using data mining methods [9, 11]. Research tries, for example, to identify usage patterns of a website and to take the results as a basis for optimizing the website's structure and to show advertisements. Another aim is to work with automated recommendation systems [12, 13].

Working with logfiles is summed up under the term web usage mining [14 - 16], a subcategory of data mining [17, 18], which aims to transfer existing data mining methods to the field of the internet or web. Practically, there are mainly five ways used by other researchers to conduct logfile analysis:

1. A descriptive analysis to display which pages of a website are accessed more than others and how many users selected a specific function, e.g. the search function [19]. Many free and commercial logfile tools have these capabilities too.
2. Besides descriptive analysis, logfiles are used to show paths from users or visitors through the site. One often-used algorithm here is sequential patterns [20], for example [12, 21 - 24].
3. Logfiles are also used to cluster users or visitors into groups. The clusters are based on movements or paths through the system.
4. Social network analysis [25 - 27] to display connections between users and/or websites are based on the "clickstream"-data [18].
5. Adapting other statistical methods and algorithms (e.g. multilevel analysis) for logfile analysis.

In contrast to other methods, logfile analyses have the advantage of being non-reactive. All information is gathered on the application layer or server layer and not registered by the user. Furthermore, the data are stored in a machine-readable format and can be used immediately. The main disadvantage, from the researcher's point of

view, is that one has no information about the user's intentions and goals. Furthermore, there is usually no information about the user itself like gender, age, etc. The logfiles themselves only show the users' behavior within the system. This applies especially to the last action within the system as we do not know if the user reached her goal or not.

Beside these problems, uses of logfiles can lead to high privacy concerns. The users normally have no control over the logfiles that are produced by the server or application. Therefore, logfiles must be made anonymous by researchers.

3 The School Information System Used

The research project was conducted in two schools in German cities with more than 100,000 inhabitants. Each school had more than 100 teachers and more than 1,000 pupils. The results show the behavior in one of the two schools. The School Information System (SIS) was used among the staff to coordinate and communicate with each other. It was hosted by an external company and had limited administrative effort need in the school. Additionally, it had the advantage that the SIS could be accessed not only from inside the school, but also from home.

The SIS offered the following opportunities for the staff to communicate among each other:

- Announcements.
- Dates.
- Materials and files.
- Discussions.

The system also offered a Learn Management System (LMS) for teachers and classes. Users entered the system via a fixed Uniform Resource Locator (URL). Changes could also be followed via Really Simple Syndication (RSS)-feeds, dates could be subscribed via iCal and therefore be used with Smartphones and extended groupware-programs (Outlook, iCal for Mac, Mozilla Thunderbird).

The system's structure was somewhat different from normally-used information systems. These tend to use a hierarchical structure like classes within grades or classes within subjects. This system offered a much flatter system with intense usage of categories and keywords. Every item (announcement, date, etc.) could be put in several categories and could be tagged. This was especially important for working with materials.

Users needed to work with categories and keywords or use the search function to find the relevant materials. All materials could only be sorted by name, creation date and user. This meant that materials had to be tagged to ensure other users could find them as scrolling and searching manually was ineffective. So, one material could have more than one file.

Announcements did not rely on correct categorizing and tagging as there were not many new entries. The overview page (which was similar to the overview page of the materials) showed the main information and usually all new entries. Dates were not dependent on correct tagging and categorizing either, as the system offered a calendar

view that showed all dates, ordered by month, week or day. As mentioned above, dates could also be accessed with handhelds or Smartphones that also did not rely on keywords and categories.

The analyzed logfiles ran from March 2011 to March 2012, with some interruptions, especially with no entries from the end of April 2011 to the middle of June 2011. We had a total of 120,000 hits during the whole period from 138 users. After the deletion of all iCal and RSS accesses and path completions, the sum of hits was about 62,000. The 138 unique users had a total of 4,451 visits (a visit defined as a sequence of hits from a unique user, ending after 30 minutes of inactivity [28]).

4 Preliminary Outcomes

We analyzed the logfiles in different ways and took the five afore-mentioned ways in section 2 as a basis. At first, we looked at the descriptive statistics of the users and their access patterns in the SIS and identified three groups: heavy; medium; and minor users. There is a smooth transition between minor and medium users and a bigger gap between medium and heavy users (see Figure 1). Minor users have between 0 and 17 visits in the monitored period, and medium users between 18 and 200 visits. Most users of the SIS (a total of 138) were classified in the minor group (79), with about 40% in the medium group (56) and only three users in the heavy users group. We assumed that the three heavy users belonged to senior staff. Observations and group discussions supported this assumption, but as logfiles were taken anonymously, we could not be sure.

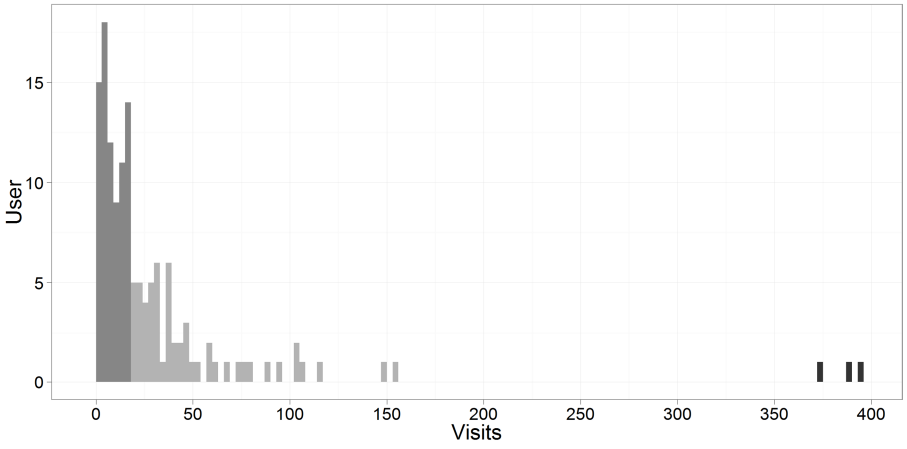

Fig. 1. Different groups according to visits

The SIS offers a variety of collaboration options, e.g. announcements, invitations, materials and discussions. Materials and dates are accessed most frequently, followed by announcements. Teachers accessed the SIS especially from Sunday until Tuesday, and slightly less on Wednesdays and Thursdays (see Figure 2).

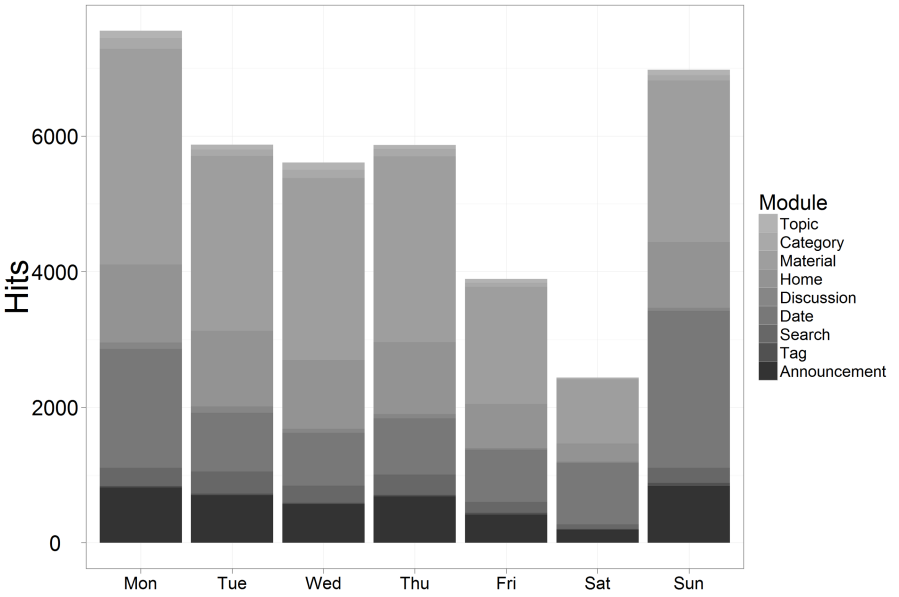

Fig. 2. SIS access by weekday and modules

After looking at descriptive statistics, we took a deeper look at user patterns within the system. Using web mining techniques [17] we transformed the logfiles into real clickstream data, which enabled us to follow the navigation from users within the system. In detail, we worked with the accessed URL in the logfile and the accessed URL in the next line (see the logfile examples above). We used these data to draw social networks with items as nodes and actions from one item to another as edges. This step offered us several advantages. Firstly, we got an overview of the complex system. All accessed items were displayed on the network map arranged using force-based algorithms [29], which meant that nodes connected through frequently-used navigational paths were displayed closer together (and pages containing user information were excluded from further analysis). This also implied that we did not recognize any items that were not visited. Secondly, the edges indicated "movement" between items and showed strong relations between two or more nodes and highlighted central nodes (gatekeepers). One outcome for example was that tags, groups and school subjects (beneath index-pages) were mainly used to navigate through the SIS. Within subjects, linked items were also one main source of navigation. Social network analysis software offered the possibility to color the nodes by their type (material, date, announcement, tag, etc.) and model their size by using visit numbers. This meant that thicker nodes had more visits than thinner ones. Using these features, we could display this outcome in a very comfortable way.

The network graphics in Figure 3 show the analyzed SIS as a whole. There are three eye-catching groups in the upper part of the graph, each one connected to one category. These categories are (from left to right): miscellaneous; reports; and conferences. All are mainly linked to dates, some announcements and materials.

Announcements and materials are more likely to be accessed than dates. This is no surprise as dates can be viewed in a calendar-like overview. The items themselves are mainly linked to the category and not linked among themselves.

In the bottom left are many materials closely connected to each other. Above these materials are the two subjects English (bigger) and Spanish (smaller). In contrast to the representation of the former three categories, the nodes are overlapping each other and are not only linked to the subject itself but also to each other. This indicates that the items are closely linked together. The relative big node size is another indicator for the higher level of material exchange within these two subjects.

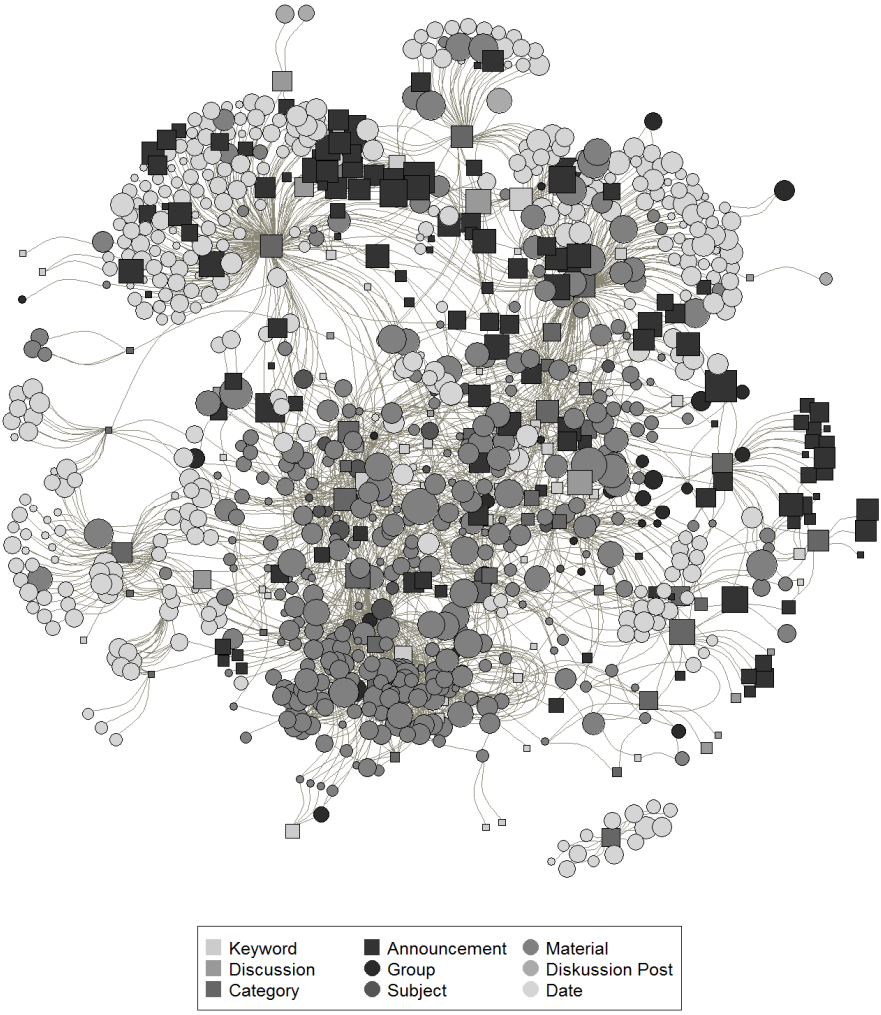

Fig. 3. SIS represented as a network graph

In the middle of the graph more subjects are to be found, but the representation does not highlight them. Above English and Spanish is a stronger concentration of subjects, which include mainly STEM subjects (science, technology, engineering and mathematics). All subjects have connections to materials, categories and keywords, but as said before, no subject is eye-catching. But they are connected to some of the most accessed materials in the system, which makes it important to take a closer look at all subjects, not only English and Spanish.

Figure 4 shows a scatter plot with number of materials per subject and the sum of hits of these materials. The plot shows only materials created within the logged period. Previously-created materials and materials that do not have a direct link to teaching were eliminated. The size of each subject shows the number of different contributors. The plot shows that English has the most hits (2,300) and the most new materials (23). Seven teachers contributed materials to the subject. That is no surprise and was already assumed. Spanish, on the other hand, is more interesting. It has the second most new materials (15), but only around 500 hits and only three contributors. Social science, the subject with the third most materials (8) has 1,500 hits on those materials. It has also more contributors (6). Other subjects like mathematics, German, business studies and chemistry have all less than five new materials during the period, but more accesses than Spanish. One explanation may be that there are more teachers in English and STEM subjects than in Spanish. Having only three teachers that are exchanging files throughout the system in a language that not many other teachers in Germany understand and speak (in contrast to English), means that it may depend on a small focus group of these materials. Teachers from other subjects may also not be interested in these materials due to the language barrier.

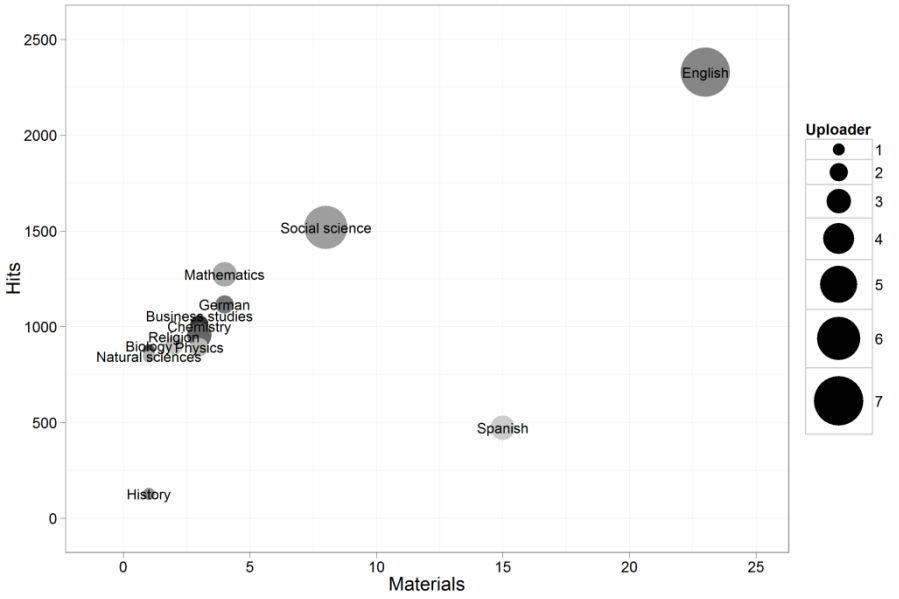

Fig. 4. Materials and accesses by subject

5 Limitations of Logfile Analysis

In general, logfiles can give researchers a useful view into a system and its usage, as shown in the previous section. Their technical background offers some neat advantages. Firstly, logfiles are already stored in a machine-readable file with a predefined format (e.g. Extended Common Logfile Format). This offers easy data management and also easy appending of new logfiles. Secondly, logfiles are usually enabled in web-based systems and can easily be adjusted to researchers' needs. The greatest advantage of this method is their non-reactivity. The knowledge of being supervised may lead to unusual behavior, but in logfile analysis, the users do not know that their actions are monitored.

This leads of course to ethical and privacy concerns. Ethical concerns may be solved by informing the users afterwards that they have been monitored and remove those users who disagree to the method. Privacy concerns are often connected to privacy laws, which, for example, prohibit the identification of users. Providers truncate IP addresses or identifier fields sometimes in order to fulfill these requirements, which may hinder logfile analysis.

But there are three more main disadvantages we discovered in logfile analysis:

1. *Combination with other data:* Due to privacy laws, users can usually only be identified by the IP address (and Browser-OS field) or an extra identifier field. These identifiers cannot be combined with additional data like gender, age, position, income or the subject in which a teacher gives lessons. Even if users accept the combination of different data sources, it may be impossible to do so as they usually do not know their internal user identifier or IP address.
2. *Identifying significant behavior:* The analyzed data had a time span of about 300 days. There may be the possibility to overlook significant behavior as the amount of data is large and significant behavior might not be the most common behavior. Additionally, commonly used statistical methods like sequential patterning or cluster analysis try to find common and frequent patterns, not rare or unique patterns. This may lead to a mismatch between available methods and research aims. However, the (normal) size of logfiles requires quantitative methods and cannot be analyzed by manual methods like inspections.
3. *User aims:* User paths or actions do not automatically reveal user aims. This applies especially to the last action of a visit. There is generally no information about the aim (the reason for using the system) itself and if the aim was reached by the user. All accessed items of a system (e.g. material, date or announcement) during a visit may also not indicate what a user was searching for or planning to access. The user could just drift through the system or check all new items.

These problems restrict the (scientific) outcome or results of logfile analysis, especially when working with assumptions and hypotheses. As long as the data cannot be combined with more information that reveals the user's aims for using the system, it is not easy to explain more about the usage.

6 Conclusions

Logfile analyses allow the researcher a deep insight into user patterns within a SIS. Furthermore, the data collection is easy and non-reactive. Initial results show a diversity of the system's usage with respect to users, items and actions. To identify these, we conducted descriptive analysis and social network analysis.

Currently we are working on a next step, clustering users to profiles. This will help to identify typical usage patterns within the SIS. As logfiles are anonymous, this can help us identify main actors within the system and help us to eventually diversify the above-mentioned three groups. Web usage mining might also help us to better identify important items within the system. We conducted multilevel analysis [30] to find out which characteristics of an item led to higher requests. Results indicate that the access to a new item depends on the item itself, its type and (of course) the time elapsed since its creation. The user who created the item also plays an important role.

Nevertheless, anonymous logfiles limit us in revealing more about the user aims. We therefore do not only use logfile analysis to test the hypotheses of our project, but also rely on participant observations and group discussions. This combination, for example, helped us to gain more information about the teachers' behavior concerning the uploading and accessing of materials of different subjects. During the participant observation, we discovered that English teachers are using the system quite often and group discussions revealed that one Spanish teacher started uploading materials into the SIS and two other teachers followed this behavior during the research period.

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Part III

What New Educational Management Information Systems Are Being Developed?

Data Sharing between Local and National Governments for the Benefit of the Citizen

Online Free School Meals as a Transformational Project

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Abstract. The Online Free School Meals (OFSM) project [1] is an example of transformation through information technology (IT) in local and central government. It brings together several central government departments in England, removes a bureaucratic process for the citizen, speeds up the process significantly, saves money, removes the stigma of benefit claim, and enables automatic audit and renewal [2]. The OFSM project was led by Connect Digitally, the team that introduced online school admissions across England [3]. The project brief was to develop a solution which would check parent/carer eligibility based on minimal criteria across the three central government databases which held the essential data, namely, Her Majesty's Revenues and Customs (HMRC), the Home Office (HO) and the Department for Work and Pension (DWP). The project resulted in the Eligibility Checking Service (ECS, previously called the Hub) [4] which from three key data items – family name, date of birth, and National Insurance number (NINO) or National Asylum Support Service (NAAS) registration number - can deliver an immediate eligibility response in over 90% [5] of applications via a web interface. The large response from local authorities (LAs) across England and Wales led to over 149 using at least some of the facilities of the ECS [6] and many incorporating the full web service process, saving money, time and delivering a beneficial service for the citizen. This paper looks at the original process, the development of the system, the current take-up and the future of OFSM in England.

Keywords: Online free schools means, eligibility checking service, Connect Digitally, Department for Education.

1 The Free School Meals Application for Eligibility Process

Access to free school meals (FSM) in England and Wales is a means-tested benefit dependent upon the circumstances of the parent/carer [7]. Eligibility for this benefit enables the children of the parent/carer to receive free school meals and free milk at the school they attend. As a key indicator of deprivation, FSM eligibility is currently used for other benefits such as Pupil Premium [8] and Early Years' funding [9]. As such, it is becoming a key indicator and funding conduit for Local Authorities (LAs)

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 107–118, 2013.

and schools. Originally, the process of applying for the benefit was bureaucratic, time consuming and stigmatised for the applicant, requiring paper application and proof of benefit to be presented to the school or/and the LA on an annual basis. From 6 April 2010 these criteria applied to children whose parents were in receipt of the following support payments [4]: Income Support (IS); Income Based Job Seeker's Allowance (IBJSA); Support under part VI of the Immigration and Asylum Act 1999; Child Tax Credit, provided that their annual income was less than £16,190 (as assessed by HMRC) and they were not in receipt of Working Tax Credit; The Guarantee element of State Pension Credit; and Income Related Employment Support Allowance.

In addition, children who received Income Support or Income Based Job Seeker's Allowance in their own right were also entitled to receive free school meals. It should also be noted that children who received "education suitable for children who have not attained compulsory school age" would need to satisfy the additional requirement of "receiving education both before and after the lunch period", before being eligible to receive free school meals.

The FSM service is administered by LAs, although in some cases this function is devolved to schools within that LA. Until 2009 the application was generally a paper-based process in which the parent/carer was also required to submit proof of eligibility to the LA in which they lived or to the school their children were attending. Examples of evidence might be a letter from the Job Centre, a payment book, a pension book, asylum seekers documentation, etc. Generally the LA or other checking authority would take the documentation supplied by the parent on face value, although sometimes further manual checks with the appropriate authority were required. The process for the parent of supplying these documents could be time consuming and the checking could take several weeks if done manually with the appropriate authorities.

For automated electronic checking, the data that would enable LAs to check the eligibility criteria directly are held by 3 central government agencies: DWP; HMRC; and HO.

2 Parental Experience in Applying for FSM Manually

Applying for FSM using a manual method can be lengthy and can involve a large amount of form filling, visits and postage. Figure 1 [10] shows the 5 steps of the process.

Awareness. In order to apply for FSM the parent will need to be aware that the benefit is available. Agencies that give support may not be aware of or inform the parent of FSM benefits. This can lead to an extended period in which the child does not receive a proper meal or the parent suffers financially.

Proving. When the parent is aware of the benefit, they will need to obtain the appropriate documentary evidence from the supporting agency (examples as described above). This may require a visit, letter or other method and may take several weeks.

Applying. Once the evidence has been obtained, the parent may complete the application. The form will then need to be delivered or taken to the school or LA.

Receiving. The appropriate authority will look at the evidence and make a decision. This may take several days or weeks in more complex cases. Eventually the child will receive the free meal entitlement and if appropriate back payment may be made although this can take several weeks.

Reapplying. After a year there is a requirement to reapply, although notification may not be automatic in which case the child may miss out on the entitlement. The process will need to recommence from step 1.

This, in addition to the stigma attached to applying for the evidence to support the FSM status, often acts as a disincentive to parent/carers to continue their application or even start it in the first place. This can have detrimental effects on their children's health and attainment [2].

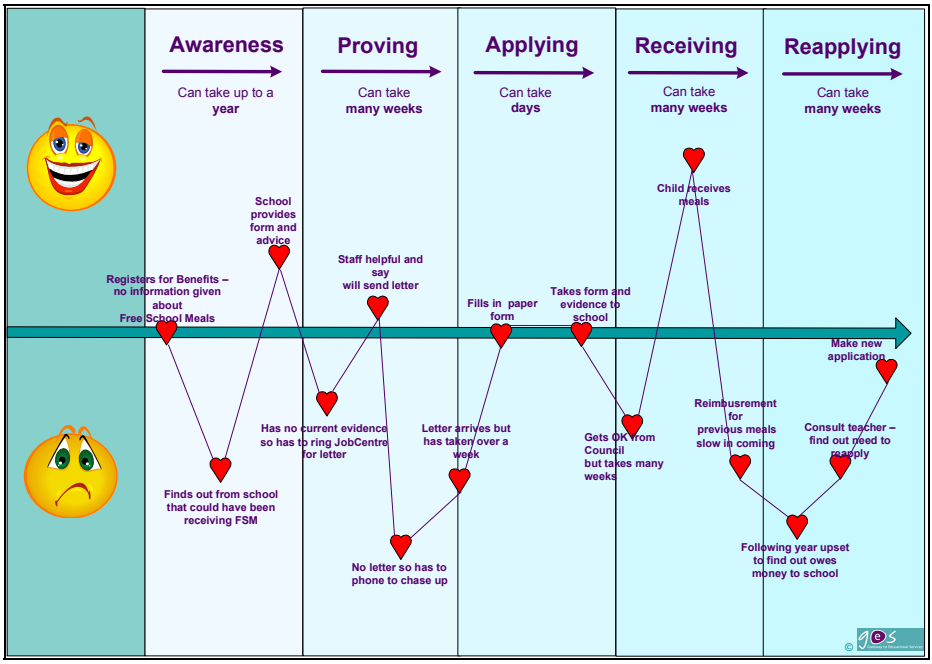

Fig. 1. Customer Journey before OFSM

Figure 1 shows the highs and lows of applying for FSM before the OFSM project was completed [10]. As can be seen, there are considerably more lows than highs and the time line can be extensive.

3 The OFSM Project

In 2007, in line with the Varney Review [1], which highlighted the need for social inclusion, joined up government and citizen empowerment (citizen centric services), a project was initiated to cover the following recommendations of this review:

- Promoting social inclusion.
- Demonstrating data sharing between central government agencies and LAs enabling LAs to check eligibility criteria for FSM without requiring paper documentation from the parent/carer.
- Illustrating joined up government in action: central and local government working together for the benefit of the citizen.
- Designing a service around the citizen: removing the burden of proof from the parent/carer and eliminating a potential barrier where parents/carers feel stigma if they have a face to face meeting regarding FSM.
- Transforming the delivery of a national service namely FSM.

As a project, OFSM highlighted a number of issues and challenges. These were:

- Data sharing between central and local government.
- Legal gateways.
- Differences between different types of LAs.
- Equality of services provided to citizens served by 150 LAs.

The eAdmissions National Project [3], led by Hertfordshire County Council, had 3 years' experience in working with the 150 LAs on the delivery of an online school admissions service for parents/carers. The project's success in redesigning the service from the parents'/carers' perspective was demonstrated by an 18% national take-up of the online service in the first year: an unprecedented level of take-up for a national service provided by LAs [3]. As FSM fell within the Department for Children Schools and Families (DCSF) (now the Department for Education, DfE) policy area and DCSF were keen to use eAdmissions' expertise and knowledge to inform the online FSM project, it was agreed that DCSF and members of the eAdmissions National Project team would work with the Cabinet Office and Tameside LA on the development of online FSM, within the wider DCSF programme the "Gateway to Educational Services" (GES, this later became known as Connect Digitally and the names will be used to be historically accurate but are synonymous).

The project was to look at the feasibility of linking the three major central departmental databases that contained the information that could be used to evidence a parent/carer's eligibility to FSM for their children.

Clearly this was to be a complex project requiring agreement by all stakeholders, cooperation across central and local government, user acceptance and security.

4 The Issues

One issue was that unitary/metropolitan councils are responsible for a different set of citizen services from county councils, although FSM is a service provided by all of the 150 English LAs (now 152) responsible for education. In addition, unitary/metropolitan LAs administer housing benefit and council tax benefit and in this role have access to the Citizen Information Service (CIS) provided by DWP. The CIS system identifies if a citizen (parent/carer) has been awarded income support or job seeker's allowance: eligibility criteria for FSM. As a result, a proposal was made that the CIS system could be used by LAs to determine eligibility criteria for FSM. This would enable the majority of FSM applications to be resolved, though not for applications requiring access to HMRC or HO data. However, DWP and DCSF lawyers raised doubts as to the legality of this approach and in addition LAs do not have access to CIS, and to achieve true transformation, equality of service had to be provided to all citizens. The LAs are responsible for administering around 30% of FSM resulting in a large proportion of the country being excluded from the project.

It was agreed that to achieve genuine transformation, data sharing must be enabled for all LAs providing FSM and as such the use of the CIS was dropped.

5 The Solution

The solution was the creation of the DCSF FSM hub, a unique system designed to streamline the process for FSM eligibility checking and reduce the burden on parents/carers and LAs. The system allows LA users to undertake record checks from one central point, the DCSF Hub (now the Eligibility Checking Service, ECS), of the data held by the DWP, HMRC and HO to establish FSM eligibility. Checks may be performed for an individual application or in batch mode.

As a result parents/carers no longer need to provide paper evidence of the relevant tax or benefit information to confirm FSM eligibility. A central check on National Insurance number (NINO) or National Asylum Support Service (NASS) reference number, family name and date of birth are sufficient to confirm eligibility. Basically the ECS acts as an interface to the three central government databases. These are HMRC, for data on tax credits, DWP, for data on income and benefits, and HO, for data on asylum seekers. A web interface enables the LA to check against the applicants three key data items (family name, NINO or NAAS and date of birth) and a response from the ECS is almost immediate, resulting in a 'Found' (Eligible) or 'Not Found' (not known) response. A 'Not Found' response will indicate that the applicant is not eligible or that their data is missing for some reason. Because of a delay in updating some of the central databases and some missing data an eligible applicant may be flagged as 'Not Found' when they are in fact genuinely eligible. This can be resolved by resubmitting the application the next day or week or by the parent presenting paper evidence to the LA or school. Despite this slight disadvantage of the

system, it has been shown to identify over 90% of queries correctly [6]. The system allows details to be checked as a one-off or in a batch of applications. It can also be used to check renewals on a regular basis as well as audits of existing eligibility.

6 The OFSM System as an Incremental Citizen Facility

OFSM using the ECS may be developed by LAs through a variety of increments, each giving more value and effectiveness.

1. Use the DfE ECS for FSM applications, renewals and audit. Whilst the application may still be made through non-IT methods, e.g. phone, visit,; paper form, there is no need for the LA to check the accompanying paper evidence as the LA is able to check eligibility through the use of the ECS using single or batch process. The use of the ECS for audit of existing eligibilities on a periodic basis removes the need for re-application by the parent and will indicate where eligibility has lapsed.
2. Improve the LA business process and remove the need for paper proof of benefit at application and renewal. The removal of the requirement for the parent to supply eligibility evidence on application removes much of the storage and retrieval issues for the LA and makes the process easier for the parent.
3. Introduce online forms for parents/carers to apply for FSM. The introduction of an online form means that the parent no longer has to use paper-based or personal methods to communicate their application for FSM.
4. Use web services to provide a seamless OFSM service to parents/carers. Web services ensure that the parent and LA gets a response in real time to their applications.
5. Work with schools, suppliers and caterers to ensure that free school meals are provided for eligible children by the start of the next working week. In tandem with stage 4, the use of electronic methods to communicate eligibility to schools ensures that the meal can be provided as soon as possible, ideally the next day.

7 A Transformed FSM Service

The successful rollout of the DfE ECS has enabled LAs to provide a more streamlined service. The burden of proof has been removed from parents/carers eliminating the paper documents currently required by LAs. The timescale for responding to a FSM application has be reduced to between 24 to 48 hours instead of, in some cases, several weeks.

Building on the experiences gained with the proof of concept models in Tameside and Hertfordshire LAs, the long-term goal was to provide the solution outlined for all LAs: a secure online service to parents/carers, linked via a web service to the Hub, enabling an immediate response to the application and direct notification to the appropriate school. At the time of writing, there are 17 LAs utilising the full service.

8 Parental Experiences with OFSM

Figure 1 illustrated the parental experience of applying for FSM using the old paper method. Figure 2 [10] shows the experience using a full web enabled OFSM system. As can be seen, the whole process is faster, streamlined and avoids stigma.

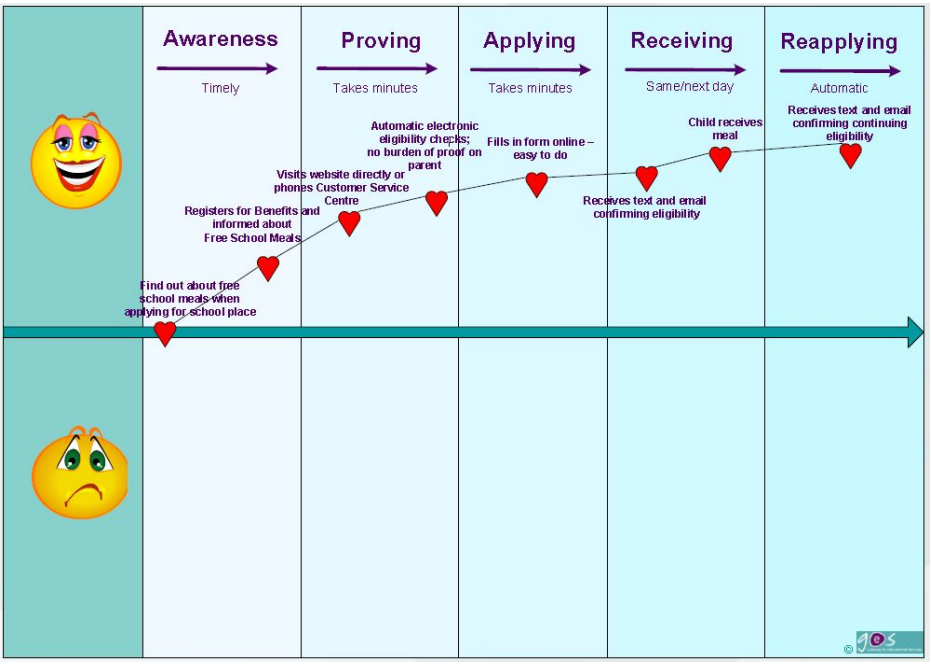

Fig. 2. Customer journey with OFSM

It also has efficiency and financial advantages for the LAs, discussed later in this paper.

9 Uptake of ECS Usage

The take-up in usage of the ECS has been high. Figure 3 [5] shows the number of LAs using the ECS between 2008 and September 2011, on a month-by-month basis. As can be seen, the number of LAs has increased month on month across the 3 year period. This will level out as we reach saturation point, i.e. all LAs using the system. These data show all types of usage from one-off checks to full web serviced systems. As the system becomes more embedded, LAs will move through stages of maturity.

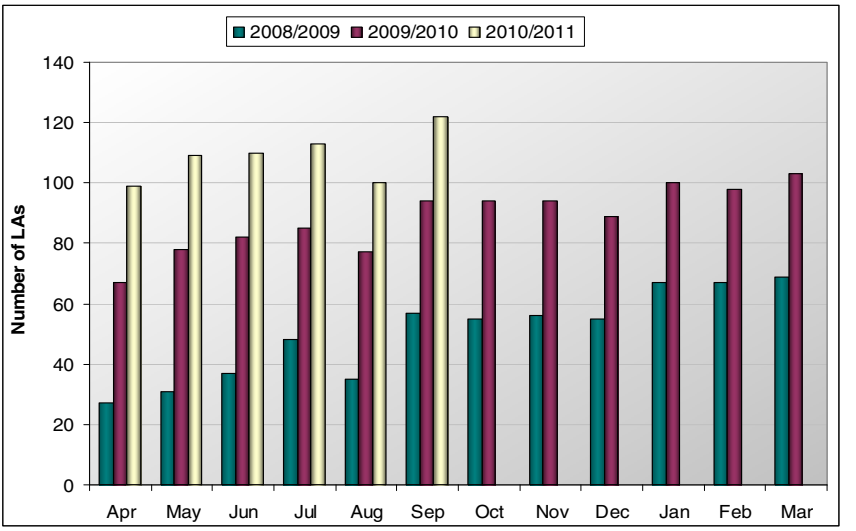

Fig. 3. Number of English LAs using the FSM ECS

Figure 4 [5] shows the number of queries made to the ECS on a month on month basis across the same 3 year period. It can be seen that the number of queries is not only increasing with the number of LAs using it, but also as a result of the use of the ECS for audit purposes as well as normal applications. Some LAs audit as frequently as weekly, meaning that as soon as an applicant becomes ineligible the FSM can be stopped. Alternatively where an applicant has been indicated as ineligible, the audit may find they are now eligible and the FSM may be resumed.

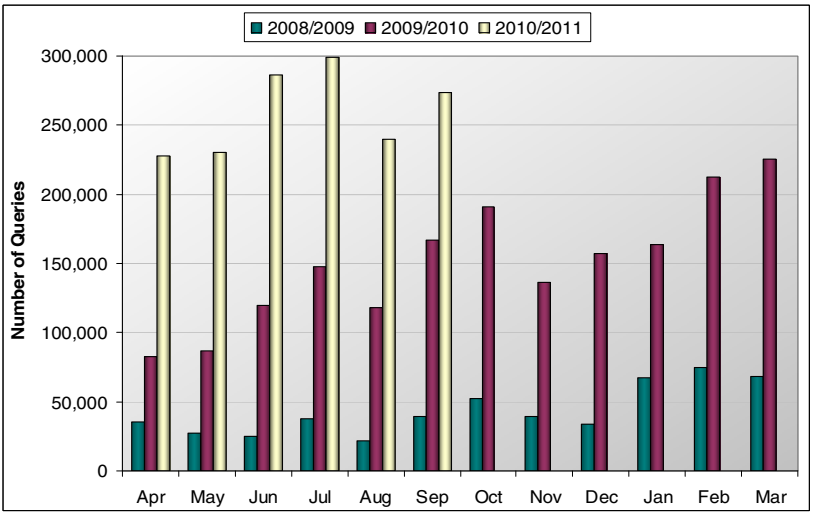

Fig. 4. Number of FSM ECS queries by English LAs

Figure 5 [5] shows the number of ECS queries each month in 2009 and 2010 as batch and online. It is interesting to note that although the number of batch queries has increased, the number of online ones has increased less so. This results from the considerable extra work involved in setting up an online system with less financial benefits. As a result, only 17 LAs currently have this feature, but these do represent a large number of queries showing that the process is well used.

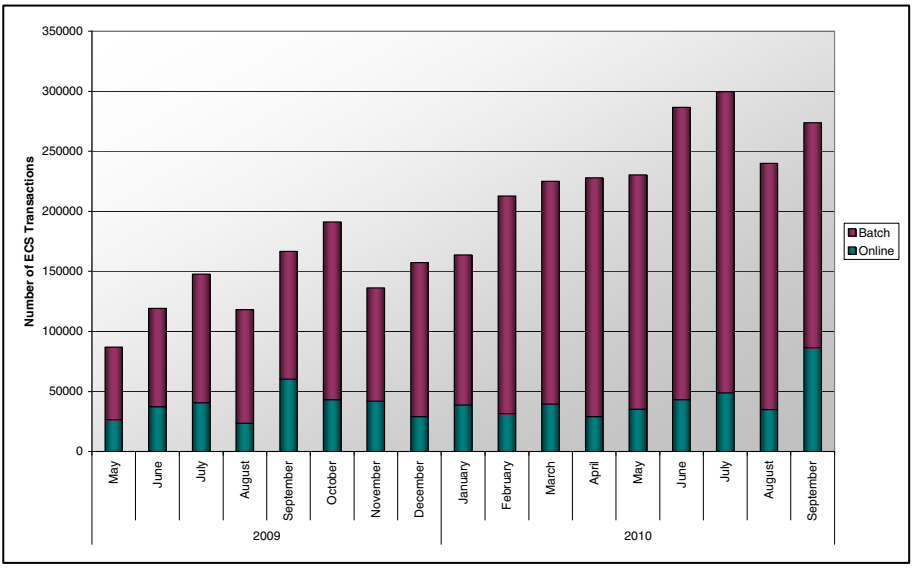

Fig. 5. Number of ECS queries each month (England).

10 Current Position

The latest figures show take-up of the ECS across England and Wales [5]. Of the 152 local authorities (LAs) in England with responsibility for education, 143 (94%) used the DfE FSM ECS in November 2011. One hundred and fifty (98%) LAs used the ECS since the service started.

There were 527,569 transactions within England and Wales during November 2011: 430,544 were batch queries; and 97,025 were single queries. Currently 39 LAs run audits at least once a month and 29 more LAs run audits at least once a term. One hundred and fifteen English LAs no longer ask for paper proof of benefit to process free school meal claims.

In addition to providing a better system for the citizen, the use of the ECS has resulted in efficiencies, demonstrated below by evidence from various LAs across England and Wales [5]:

- 10,000 fewer citizen call, saving £20,000.
- Reduction in staff saves £98,000, and reduction in office space saves £6,000.
- Fewer queries from schools saves £5,000, and improved audit process £18,000.

- Expenditure on leaflets, postage and manual entry of applications, saves £63,000.
- Booklet printing not needed, saves £49,000.
- Data input by temporary staff reduced from 42 weeks to 5 weeks, saving £17,000.
- Since October 2009, Hertfordshire LA identified approximately 4,000 recipients no longer eligible for FSM. It was estimated that, through not providing a meal to these recipients, around £100,000 was saved for 2010 to 2011.

11 An Example of the OFSM Web Service in Practice

A typical system using full web services would consist of the following elements:

Online Form. An online form needs to be available for the applicant from the LA website. This may be hosted within the LA's own infrastructure or rented from a cloud provider. The form will need to comply with the appropriate standards of the LA and usability guidelines. The form will need to capture applicant family name, NINO or NAAN and date of birth as a minimum; it is likely that address and contact information together with pupil data will also be required.

LA Back Office System. The results of the ECS check will be relayed to the parent, the school and the LA. There will need to be a back office system capable of holding this eligibility information including the data captured on the form. This will be required for renewal, audits and queries from the applicants. For the parent, results will be instantly available on screen and additionally by email or SMS as appropriate.

School Back Office System. Ideally the school back office will offer a narrower view of the LA system for that school only. Where eligibility checking is administered by the school itself they will be able to make changes which in turn will be reflected in the LA's view.

Data Transfer to Schools. Although the information regarding eligibility may be transferred to the school via email, similar transfer to the school might be in a format imported directly into their management information system (MIS) via a common transfer file (CTF), system interoperability framework (SIF) or similar.

12 The Success of the Project

The project has been a success, evidenced by the following awards:

- Shortlisted for the e-Government National Awards 2010.
- Local e-Government Excellence -Take-up and Usage Growth, November 2010.
- Winner Civil Service Awards - Public Service Award, November 2010.
- Runner-up for the Civil Service Communication Award, November 2010.
- Medallist, BCS UK IT Industry Awards - Public Sector Project of the Year, Project Excellence Section, November 2010.

- Winner Local Government IT Excellence Award, Service Transformation Category.
- Winner Good Communications IT Partnership Award, June 2010.
- Winner Overall Government Computing Award, April 2010.
- Winner Collaboration Government Computing Award, April 2010.

13 The Future

Since the development of the ECS, the use of FSM eligibility has increased as a key indicator of deprivation and as a conduit for funding, in particular, the introduction of the Pupil Premium which is an additional payment, on a per pupil basis, made directly to school for children from poor backgrounds. This premium is currently based on FSM eligibility and is soon to become based on any FSM eligibility in the last 6 years [8]. This will be an incentive for schools to encourage parents to apply for the benefit even if they do not wish to take the free meals.

In the future there is likely to be an increase in the number of parent/carers who go through the process of eligibility checks for FSM as a result of school pressure for Pupil Premium payments, lobbying from the School Food Trust (for healthier lunches), changes to the admissions criteria (allowing admissions priority based on FSM eligibility), and general austerity effects nationally.

The system described here will make it easier and more effective and efficient for both parent/carer and administration body, be that school or LA. In addition it should, in the longer term, make the actual FSM eligibility numbers that are used as a measure of deprivation for a large number of statistical measures a better reflection of the true position nationally. In addition, Early Years' funding is likely to be driven by FSM eligibility in the near future [9], again making use of a simple eligibility checking system an essential LA tool.

The increase in the number of Academies and Free Schools (state schools that are independent from LA control) will also have an impact on, in particular, the use of web services. This is because the legal framework for the ECS only allows LAs to have access. Academies may use their own LA but this may not be viable (the LA may charge or simple refuse to assist). As independent bodies, the academies may use any LA system through negotiation. Alternatively, a virtual LA may be set up for this particular purpose. This solution would require a full and seamless system using web services, probably using a cloud infrastructure as discussed below. The OFSM data capture form is likely to be similar regardless of which LA (or academy) is using it. The only real difference might be the branding with the school or LA banner. The use of cloud services for the form which incorporates web services for communication with the ECS would seem a sensible and effective solution, particularly for small LAs, those with fewer FSM pupils, and academies. Such a project is underway in conjunction with Software for Data Analysis [12] and Hampshire County Council.

14 Conclusions

The success of the project depended on two main criteria: an effective approach to collaboration and stakeholder engagement [13]; and a transformation that saved time, money, removed stigma and better served the citizen. There are other development areas being considered, particularly those which require paper proof of eligibility through local and national data sets, for example, school transport and free bus passes.

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Refurbishment Informational School Architecture

A Base to an Educational Information Service

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Abstract. Large technological developments have occurred over the last three decades and their impacts are affecting the management of educational systems. With cloud computing, we now have an opportunity to reshape architectures. In this paper, we present a model-based redesign for next generation technologies, to act on educational management at a school level. This redesign model respects existing system architectures, increases and organizes school communication channels and includes an intelligence element. Key performance indicators were included in an intelligence element to allow peer benchmarking and provide a refresh referential. The new referential is included in the architecture core element and will allow schools to respond to the informational needs of next level analytical engines. This redesign model intends to create conditions to develop the holistic analyses of educational management. Based on Stafford Beer´s work, it is also in the intelligence element that the interaction with the school´s internal and external environments is developed. Stafford Beer´s Viable System Model (VSM) is a conceptual framework that can be used to diagnose and resctructure organizations. In this work, we used the VSM to remodel the informational architecture of school management in Portugal.

Keywords: Educational management, school management system, Viable System Model, educational information system.

1 Introduction

Schools are units of an educational system with a great degree of complexity. They are differentiated and independent, and their autonomy is growing. Educational management, evolved mainly through technological development and the way information technology (IT) is supporting educational management processes, brings a greater capability to school leaderships.

With the introduction of personal computers in schools in the 1980s, these 'cognitive prostheses' were gaining position and can be considered today as part of daily school life. Some key processes of school organization have been automated and supported by IT. Over the last three decades, technologies have evolved, increasing their communication potential, reducing device size and increasing graphical capabilities, as well as storage and communication capacity. The model, however, has been the same throughout the whole process: the Van Neumann model [1]. The same applies to

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 119–130, 2013.

changes in management resulting from the introduction of technologies into the process. There is a growth in knowledge and technology, there is a greater organizational control of the school as an organization and, slowly, we are witnessing a shift in focus from the management of technology to the management of information. As in evolutionary stages [2], there is a change in technology, but the movement is still the same at each technological change. This path is evolving, but the device´s principles remain based on Van Neumann and technological adaptation remains based on Nolan. What changed, essentially, was broadband communications. This must have an impact on management too, at school level and its articulation to all educational fields.

Accompanying technological developments, schools were themselves equipping and developing their own informational and technological architectures. They have been developing their own information system architecture [3]. The combination of these factors, technological developments and templates, consolidated in the schools' informational system architectures, opens perspectives to our work and raises a question – how can we capitalize on the IT present at school level, to modernize, improve and monitor performance?

The use of laptops as work tools has a direct influence on lesson preparation, on the teacher and the pupil´s role, on the relationship between technologies and, for obvious reasons, on the school management process. Educational management substantiates an informational integrative perspective supported by IT [4]. The informational and technological strategic alignment [5] must also be prepared to readjust in an analogous manner to this evolutionary process. In a new phase of technology inflection, it seems relevant to define and develop a systemic solution that allows schools to monitor changes and realign strategies.

It should create conditions for schools to adapt to change, respecting their particular realities, in organizational, technological and social environments. It is known that technologies have their own life cycles [2], and this applies to systems architectures as well. It was in the field that answers were looked for with conditions that respected schools' autonomy, defending schools´ creativity and entrepreneurship. In this work, a standard solution for all schools is not an advocate hypothesis. Instead, an alternative hypothesis was followed: looking for responses in goal measurement, in its parameters and in the fashion of their application.

The evolutionary impulse, as is happening with cloud computing, will allow humanity to share information in a manner never possible before. This technological evolutionary impulse can encourage organizational and technological restructuring of schools. This moment can help the school to reinvent itself in its own organization. It can help it to aim for change, while keeping its viability within the varied and greatly complex panorama of educational management. The hypothesis following looks to endow schools with the ability to change, while preventing the crumbling of the present architecture. This work intends to be capable of proposing a way to reshape architectures, following these premises and researching for an architecture model that can successfully cope with change.

The path that was followed respects pre-existing realities, pointing out the technological change as an important moment to review the school´s relationship with its environment and take advantage of this moment to make adjustments, adaptations or,

if necessary, interventions to warrant it as an efficient technological support. That was the way followed, to define and suggest an architectural framework suitable to understand and extract information with key performance indicators (KPIs) as a base to an educational scholarship building. In a few words, a KPI list is given for peer benchmarking; a particular framework architecture is advised, but schools are independent to choose the way they do the job. To join this project, schools just needed to be able to provide data values in a proper format.

This paper aims to present an application of a cybernetic model that serves the informational and technological architectures of the school, in support of the educational system in its management process; a model that supports educational unit autonomy; a model that supports the variety and complexity present in schools; a model that works as a center to adaptation to changes, as it is demanded in contemporary contexts. It applies the Viable Systems Model [6]. The Viable System Model (VSM) is not a new idea. It was created by Stafford Beer about 30 years ago and has been used as a conceptual tool to understand organizations and support management of change.

2 Viable Systems

Viable means: passable; that can be traveled through; or that which is able to survive on its own. An organization is viable if it is able to survive by itself in a given environment. An organization is viable if it is independent, autonomous and if it has an identity of its own. A viable system requires adaptability and respect for autonomy. Its components must be able to communicate effectively.

2.1 Variety and Complexity

On the complexity of organizations, it is customary to use a wide variety of information. It is a useful guide to study at which points information is amplified and where it is attenuated. The management of variety becomes important because much of the information is irrelevant for the purpose of carrying out the task. What is needed is to act in both ways: attenuation and amplification [7]. Attenuation normally affects the collection of information and its filtering, while amplification affects the dissemination of information to an organization´s internal and external environment.

Processes of great variety bring with them complexity. To deal with the variety and complexity of information, a system that guarantees a balance between actions of long-term (the strategic part) and those of short-term (daily operational activities, coordination, etc.) is of critical importance. The systemic work must ensure that variety and complexity adapt to the constraints of external environments, while maintaining an appropriate degree of internal stability.

2.2 Autonomy and Viability

Autonomy and viability presuppose a condition of independence and ability to adapt to change [8]. It is what schools are seeking in Portugal: to develop autonomy [9] and

find the ability to adapt to change, responding to contemporary demand. Autonomy involves the ability to learn and to live with one´s own rules and responsibilities. Viability implies that those rules allow for positive work, controlling operations in a positive way. The set of rules, the conduct and the behaviour should allow all components to solve their problems independently, providing decision-making to its various elements.

3 The Viable Systems Model

A Viable Systems Model (VSM) is now also a tool for studying a structure´s organization [10]. VSM is a model centered on recursion relationships to support the viability of organizations. It is designed to respond to the environmental changes in which it is involved and to prolong its topicality. The main characteristic of this model is that its systems are recursive, adaptable and able to survive, even in environments of great variety and complexity. The system must have the ability to adapt to change and to generate, by itself, metamorphoses that respond positively to external and internal environmental changes, thus keeping itself feasible over time. VSM is a model that grants autonomy and ability to communicate in all its components. This model also ensures viability and is composed of five elements, adaptable and able to survive changes in the environment. These elements are focused in two main situations. One concerns operations and the immediate time. The other focuses on future prospects for the organization – how it will evolve, which paths it should follow and what position should be assumed in future actions. In a highly summarized form, the top management (Sub-system 5) assigns work of an operational nature (Sub-system 1), coordination (Sub-system 2), while controls, checks and audits (Sub-system 3) deal with the environmental conjecture guidance system (Sub-system 4) and defines and establishes political dimensions. Its aim is to enable a structure that provides people with resources and communication channels to constitute actual iterations [11].

3.1 Two Roles for Viability – The 5 Sub-systems for Organizations

The VSM corresponds to 5 recursive sub-systems to maintain systemic stability. In five words: operations, coordination, monitoring, intelligence and policy.

Sub-system 1: Operations. These correspond to primary activities; they have responsibilities in producing records, the core of this recursive model. Recursion in VSM is represented in Sub-system 1. The primary tasks have their own information channels to communicate with their environment in terms of daily requirements.

Sub-system 2: Coordination. A viable system also has sub-systems dedicated to the coordination of added value functions and surrounding primary activities. In summary, the second sub-system is a system of rules and procedures that should allow multiple systems to resolve their own problems, providing them with decentralised decision-making capacities.

Sub-system 3: Checks and Controls. Controls: This sub-system handles daily activity management in the base system, sub-system 1, in order to ensure the operational efficiency in the organization. This sub-system relies on information received directly from management through two-way channels. Checklist: Another important aspect is the verification channel, responsible for auditing and monitoring, which connects directly to the operational activities of sub-system 1. The label 'audit' means the ability to examine activities in sub-system 1.

Sub-system 4: Intelligence. The basic tasks of sub-system 4 are research and development, market research and organizational planning. It should maintain a correct balance between external environments and primary activities, supplying the organization with regard to market conditions. External factors are likely to be relevant in the future of the organization and, secondly, to assume an identity and to communicate into the internal environment. It intends to propose bridges between internal developments and external trends.

Sub-system 5: Politics. Sub-system 5 supplements the viable system and has the task of handling politics. It assumes the role of a judge for the organization. Compared to the complexity of the parts of the organization, this function is, by definition, a low-level process.

4 The VSM and School Informational Architecture

The information architecture model designed and proposed here is based on Beer´s VSM. To be a part of the cloud, each school can have its own architecture, although information needs must be respected. The model adaptation has five elements and covers all schools' existing processes. From operations to strategies, passing through communications, the VSM adaptations are designed in terms of approach to the school processes of daily activities and relationships between processes. This informational architecture remodelling respects current realities and assumes that each school is autonomous in decision-making. Each school has its own educational project, its own rules and its own curricular project. Each school decides how it should communicate with the community. Each school decides how to control financial, curricular and pedagogical processes, and even the software management to support them.

In this project, the way in which schools collect their data is free for them to choose. It can even be human-based if they make this possible, but all schools aggregated to the project must be ready to provide results based on the KPIs present in the advised intelligence sub-system. Providing results should be done through a recursive structure, which obtains information produced at an operational level and measures it with educational KPIs – what teachers teach, what students learn in the conditions created for learning development at each school and so on. The facilitation of information uses a recursive structure too, aiming to support political decisions and to show all administrative levels how relevant they are to school trends. This model is

intended to be suitable for the recording and collection of informational transactions, control and monitoring, and to be able to produce 'intelligence' in supporting the school´s environmental adaptability. The viable system model application proposed was inspired by the school performance feedback system (SPFS) theoretical framework developed by Visscher [12].

Sub-system 5: Politics. The executive school board and the school director have the responsibility to define political and strategic school orientations. This body produces strategic documents such as the school´s educational plans. It is advocated that policy definition must be strongly supported by the aggregated information system and its strategic orientations [13]. The decision-making process must be affected by information provided by the school management system in sub-system 4.

Sub-system 4: Intelligence. This element is responsible for analytical tools and management map production, based on educational KPI measurement and external interactions (with government institutions, parents, etc.). The KPIs imply an automated readiness to allow its measurement. These applied indicators result from Portuguese educational inspections. The information required by the Ministry is provided by this element. This is also the element in which performance results must converge. It is responsible for converting the information into knowledge at a school level. In order to do it successfully, information capture must be KPI-targeted.

Sub-system 3: Control and Monitoring. Audit and control, in the Portuguese education system, are the responsibility of the education inspection (IGE). In spite of this, internal control sub-systems may be defined in the school environment. Examples can include control systems responsible for monitoring attendance, objective accomplishment, school abandonment or others.

Sub-system 2: Coordination. Coordination activities are supported here and automated with course coordination, subject pivots, and departments are provided for by this element. Coordination instruments for teachers´ schedules, class sizes, laboratories and classroom use are also included here. Meetings and correspondent records are a coordination activity here too.

Sub-system 1: Operations. All subjects related to daily activities must have their records in this element, such as teaching activities and teaching activities´ support systems, their planning in daily records as well as evaluation moments and disciplinary issues.

Communications. At the moment, schools use institutional emails, newsletters, institutional websites, social networking platforms, Moodle (in locations specifically selected for its applications) and the student digital booklet. The way in which each component of the VSM performs its function is very dependent on how it communicates within itself and with the other elements. The four communication VSM areas carry information from the school management to the operations unit and between

internal and external environments. The communication channels used in schools are distinct and have different functionalities, including a broadcast and an individual function. They should take into consideration the ability to mitigate or amplify a certain amount of relevant information. They are vehicles for communicating between components of the VSM. Supporting communication into and out of school is a vital element, structural in terms of its autonomy and its viability. These channels also include in themselves a great variety. For example, to have an effective student assiduity control, it is necessary that this control communicates quickly and efficiently an assiduity failure. There is a need to communicate this failure both to the interior and the external environment. With teachers´ assiduity control arises the need to communicate quickly or in advance so that a class replacement can be carried out.

5 Including Key Performance Indicators in the Intelligence Element

The first problem that arises in defining indicators is their selection. There are questions related to their nature, such as whether they should arise from a theoretical framework, or if they should simply be selected from already tried and tested sources. The task of establishing a typology of indicators should be understood as a permanent work in progress [14]. In this project the decision regarding indicator selection was to use the indicators from Portuguese schools' assessment [15], which is based on the Scottish work "How good is our school". It was decided that the list would be complemented by some indicators used by the OECD [16] to enrich the monitoring system.

Five domains of action were defined and each one has its own parameters. The five domains are: Results; Educational Service Provision; Organization and School Management; Leadership; and Extras. The KPIs for each domain follow.

5.1 Domain 1 - Results

Academic Success:

- Progression, retention and drop-out rates per school year, year of schooling and study cycle.
- Student transition rates, with recovery plans and monitoring – according to school year, level of education, course and year of schooling.
- Transitional rates for pupils with special educational needs.
- Distribution of classification levels in secondary school examinations.
- School curricular subjects with success and failure identified.
- Internal assessments versus external result comparisons; evidence at the K-4 and K-6 levels.
- Internal assessments versus external result comparisons; national examinations at the K-9 level (Portuguese language and mathematics).
- Based on national secondary examination results, comparisons of internal student classification versus external rankings.
- Drop-out related to school performance.
- Number of constraints identified in school drop-out.

School Life Participation:
- Frequency of parents´ attendance.
- Frequency of parents´ and class delegates´ participation in evaluation meetings.
- Percentage of institutional email exchange between the different elements of the educational community (by groups, clusters and between groups).
- Percentage of activities proposed to the activities run in the annual plan by the student community and parents.

Behavior or Discipline:
- Percentage of disciplinary proceedings, by study cycles.
- Typology of the nature of disciplinary processes.
- Percentage of visits to the rules and procedures document on several platforms (the web and Moodle).
- Frequency of relapses.
- Frequency of attendance and punctuality failure.

5.2 Domain 2 - Educational Service Provision

Overall:
- Number of curricular subjects taught.
- Number of subject plans submitted.
- Number of subject groups, and interdisciplinary activities in the annual plan of activities.
- Measurement of coordination goals achieved.
- Teaching staff articulated in the activities' annual plan.
- Number of individual student project requests.
- Periodicity of meetings: between teachers, teachers and parents, psychology and guidance service (PGS) and teachers, PGS and parents, and the parents' association.

Accompanying of Teaching Practice in the Classroom:
- Frequency of lesson plans (number of lesson plans versus number of classes provided for).
- Number of digital resources used by curricular theme.
- Rate of completion in programmed planning.
- Mid-term evaluation of curricular class projects.
- Number of assessment instruments used by each teacher (implies the year or cycle definition of an instrument matrix).
- Completion rate for evaluation criteria (checklists).
- Common instruments used: different classes and the same year subject (checklist).
- Comparative analysis of student results from the same year and subject of schooling.

Differentiation and Support:
- Number of devices used per student with special educational needs.
- Number of additional articulations between group directors or classmates, parents and technical and special education staff.

- Number of students with special educational needs enrolled.
- Number of educational activities, curriculum and enrichment in school time (number of students enrolled).

5.3 Domain 3 – Organization and School Management

Design, Planning and Development of the Activity:
- Number of educational projects articulated and annual plan for activities; educative project, curricular project, or school group curricular project.
- Periodicity of school newsletter publication.
- Subject identification in different groups (subject/level).

Human Resource Management:
- Grouping of teacher´s academic degrees.
- Student rate by teachers.
- Number of teaching staff training credits and non-teaching staff training credits for the academic year.
- Grouping of training needs identified by knowledge field.
- Teachers that have the same classes year after year, and the number of academic years involved (pedagogical continuity).

Financial and Material Resource Management:
- Rate of classroom occupancy.
- Rate of computer utilization.
- Ratio of computers per student.
- Rate of gymnasium occupation.
- Rate of arts facilities occupation.
- Amount of funds raised by the school.

Participation of Parents and Other Elements of the School Community:
- Rate of activities with parent participation in the annual plan of activities.
- Rate of parent delegate presence in the assembly.
- Number of initiatives to support parents' involvement in student homework.

5.4 Domain 4 – Leadership

Vision and Strategy:
- Rate of objectives accomplished within the timing defined.

Motivation and Commitment:
- Assiduity rate of teachers and staff.

5.5 Domain 5 – Extras

- Series of results per academic year (a weighted average over the last 3 years).
- Level of parent education (resulting from questionnaires launched at the beginning of the academic year).

- Grouping of parental professions.
- Average age by K-level of students.
- Number of students supported by the social program.
- Percentage of students with internet access.
- K-level with most students.
- Percentage of students who drop-out from the school.
- Rate of student transiting to higher education.
- Annual expenditure per student.
- Cumulative expenditure per student over the course of studies.
- Percentage of own school capital in the school budget.
- Student cost per class.
- Foreign students enrolled.
- Student grouping by educational area.
- Average class size by cycles of studies.
- Average class size per year of schooling.
- Ratio of students per teacher, by educational level.

6 Conclusions

In this work, a decentralized model is advocated; a model in which data collection becomes the school´s responsibility. It is also advocated that creativity and competitiveness should be fostered, as tools for developing and innovating each school´s management information system. By themselves, or together with technological partners, schools from this project must collect data as presented in the VSM-adapted model. VSM and its recursion contain the same guiding data warehousing principles to satisfy modern information needs [17]. From strategies to operation, the VSM-adapted model covers all school areas with its constituent elements. Communication between its elements and its functions is another aspect foreseen in this VSM adaptation. To accommodate future trends, the adapted model brings a corresponding element. It is through this element that architecture will be able to propose information to prepare for change.

A process of autonomy growth affecting schools in Portugal is already in progress [9]. The focus of our study was strongly influenced by this process. The research line defined focuses on remodelling information system architecture in order to support school autonomy to develop information management while serving schools, communities and the Ministry. The proposed model reverses the logic of standards present in our educational system. The information standards are only used to satisfy the Ministry´s information needs and that information must be provided. The architecture´s remodelling respects and invests in school autonomy, understanding them as units of a complex educational system whose environmental relationship calls for a great variety in terms of action. It proposes an application of the viable systems model for the school, which respects its great variety and complexity, as well as the growing sense of autonomy of school systems.

This architectural model improves communication channels and control elements. By developing an element of intelligence, a school´s capacity to adapt to contemporary needs is increased. This new element brings for a school a capacity to adapt to

change, accompanying environmental trends and technological developments. The reshaping of architecture is flexible in allowing strategic alignments, and with the inclusion of KPIs in the intelligence element, creates a basis for a brand new global referential.

With cloud computing, we are witnessing one more leap in technological evolution. This new technological generation was found to be an opportunity to bring the same accountability cloud to different schools, serving leaderships, communities and the Ministry. Recursion is present at all levels of the educational system, from the Ministry to the classroom. On the other hand, just as autonomy should be encouraged, accountability should be a requirement as well, and all schools should answer to it in a similar way. Considering this, we apply a template that invests in the autonomy of all functional units, but still meets accountability standards. This architectural facility performs, with the intelligence element, by providing the heads of functional units of the education system with access to a global observation of reality, enabling them to understand what really is happening through defined parameters.

Simultaneously, the path followed applies to the various units of the educational system, granting them an ability to provide information, thus enabling them to contribute to the construction of global knowledge, to support global definitions, areas of research and accountability, turning it into an increasing phenomenon in our societies. This architectural adapted model has a clearly decentralizing effect and brings benefits to schools for obvious reasons. The information industry may also find in education a new cluster to develop, as the option for no standard solution to educational systems and the increase of schools´ freedom to choose bring important stimuli to the competitiveness between players in this particular market.

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Finding a School Technological Partner

A Multi-criteria Method for School Information System Producer Selection

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Abstract. The choice of an information system is a critical factor of success in an organization's performance, since, by involving multiple decision-makers, with often conflicting objectives, and having several alternatives with aggressive marketing makes for particularly complex decision-making in terms of choice by consensus. The main objective of this work is to create an analysis and selection method for an information system designed to support school management, pedagogical and administrative components, using a multi-criteria decision aid system – MMASSITI – Multi-criteria Methodology to Support the Selection of Information Systems/Information Technologies. It integrates a multi-criteria model that seeks to provide a systematic approach to the process of choice of information systems, able to meet sustained recommendations concerning decision and scope. Its application to a case study has identified relevant factors in the selection process of school educational and management information system and how to gain a solution that allows the decision maker to compare the quality of the various alternatives.

Keywords: Decision support system, multi-criteria decision analysis, information management systems, educational management.

1 Introduction

A school information system is seen as a vital resource for organizational support, and its proper management is essential, both at the strategic, tactical and operational levels. The existence of a tool to support decision-making in relation to the choice of information systems/information technologies (IS/IT) in an organizational context is thus of great importance.

In this paper, the problem is to address the needs for choice and selection of a school management information system (SIGE), to be able to follow the architecture designed for monitoring schoolwork. It is also intended that this SIGE demonstrates an evolutionary capacity, to follow the implementation needs inherent to internal and external environmental changes.

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 131–141, 2013.

The architecture of SIGE is already set and the purpose of this work is the selection of both a SIGE and a partner that is already acting in the educational management environment and best suits the architectural model proposed. The selected partner should also be able to leverage and develop its information system architecture in a convergent form with the model.

The process of selecting is complex and involves several dimensions: i) knowing and bearing in mind the needs framed in the architectural model - informational architecture of the school in functional terms, the strategy of its information system, organization and global strategy and operational planning of the school; ii) implementing a process that allows for systematic evaluation and is consistent, with extended alternatives that have a high number of features and attributes relevant to the evaluation process; and iii) managing a set, more or less broad, of conflicting objectives. Additionally, this process involves, systematically, various decision makers (a team of research and IS/IT development and computer operators in the school area) with different point of views and divergent interests.

The main objective of this work is to develop a comparative study of four SIGEs that are operating on the Portuguese market and which involves: i) a clear structuring of the problem, namely: a coherent and consistent family of criteria, identification of features and functionalities that should be incorporated in the decision-making process; and ii) the definition of an approach that enables objectively the comparison of the quality of different alternatives. For supporting the decision aid process, we used a multi-criteria decision support system (DSS) developed by Pereira [1], MMASSITI – Multi-criteria Methodology to Support the Selection of IS/IT, which seeks to provide a systematic approach to the multi-criteria decision process, capable of producing sustained recommendations with regard to the solution adopted in view of the particular context of education and the environmental context.

This paper is organized as follows: in section 2 an architectural model framework defines the functionality that an integrated school management system (SIGE) should cover, or possess; in section 3, in summary, the multi-criteria model incorporated into the SAD-MMASSITI is shown; in section 4 a consistent family of criteria for the specific Portuguese school context of decision aid in accordance with the methodology used is defined; in section 5 the results of the application of this methodology to the study of a case are presented and discussed; and in section 6, we present the main conclusions drawn from the application of the SAD - MMASSITI to the selection of a SIGE to support the research and development of a school information management system project.

2 Architectural Model for a School Management System

Schools in Portugal are units of an educational system with great complexity. They are different from each other, independent and with great autonomy. However, the technological evolution journey supports educational management in this development through progressive transformation. In our educational management research, an adaptation of a model for informational architecture of school management was

created – The Viable System Model (VSM) of Stafford Beer [2]. The goal is to develop school management to provide educational management.

Before going to the selection of a technological partner to this research program, it is useful to describe the architectural model docket. The architectural model adapted from the VSM has five elements, is recursive and adaptable to change. It consists of a recursive structure to obtain the information produced in different operations – in what is taught, in what students learn and in the environments related to the school. This model has five elements: (i) operations; and their (ii) coordination; (iii) monitoring and control; which is able to produce (iv) intelligence; supporting school environments adaptable to established (v) policies.

Sub-system 5: Politics. The executive team and the school director have the responsibility to set politics and strategic orientation for the school. This board produces strategic documents describing the school educative project, school curricular project and school regulation book. The political definition is supported by the information system; from its operations data are collected and used to produce management maps. Without an automated procedure, school decision-making is strongly influenced by the intelligence element in sub-system 4.

Sub-system 4: Intelligence. This sub-system is responsible for the production of management maps. It is based on school-work assessment indicators in pedagogical and administrative tasks. It is also responsible for the environment's interaction. In this element, information required by the Ministry is produced and delivered.

Sub-system 3: Control and Monitoring. In the Portuguese educational system, audit and control are provided by the General Inspectorate of Education (IGE). But elements from this sub-system can be used to keep a check on the internal environment. Examples include attendance control systems, and the school dropout control system.

Sub-system 2: Coordination. In the coordination support sub-system some automated processes for the coordination of study cycles are provided, to departments and teacher groups. In this element, coordination tools are also included, such as teacher timetables, class timetables, laboratory use timetables and classroom timetables.

System 1: Operations. Teaching activities and all teaching system support items, including plans, daily records and assessment items are included here. All daily schoolwork is recorded as data in this element.

Communications. The way each VSM element works depends a lot on the communications process, between elements, and between elements and environments. There are four communication domains in this VSM adaptation that trade information between the management element, the operation and environment elements. The tools to do this must have capacities to broadcast and to migrate information as well. School communication channels are distinct and have different functions. They exist with broadcast and directional functions and are vehicles to communicate between VSM elements, making connections in the internal as well as the external environment. Upward communication presumes a form of reduction, but constitutes a vital element, structuring and guaranteeing autonomy and viability. Schools need to use institutional

e-mail, newsletters, have presence on the web, and use social networks and Moodle (in specific places). The technological partner must have the capacity to aggregate them.

3 MMASSITI DSS

Though a large number of multi-criteria decision analysis (MCDA) methods have been proposed by researchers, none can be considered as 'The Method' appropriate to all decision making situations. All of them require a facilitator/analyst to perform them. Most of the problem solving in IS/IT selection uses the most popular and quoted MCDA methods, such as ELECTRE outranking method family [3,4], PROMETHEE outranking method family [3,4], and the AHP method [5] among others, to access the aggregation phase.

The decision aid support process generally involves incomplete, inaccurate information, multiple criteria and is a group decision problem or involves different decision-making agents.

The existing multi-criteria methodologies are based on the elicitation of values of consequences on twig-level criteria or attributes and also on the relative weight of criteria. Belton and Ackermann [6] emphasize the fact that the work done in the area of MCDA has been predominantly based on methods to support evaluation process and choice, instead of structuring the problem.

Specific procedures, based on cognitive mapping, such as COPE and V.I.S.A [6], SSA - Soft Systems Analysis [7 - 9], or Keeney's value focused thinking [10] have been used to address the structuring phase coupled with the most popular MCDA methods worldwide. The structuring phase, and consequently the definition of a coherent and consistent family [10 - 12] of criteria is crucial for the success of any multi-criteria methodology because criteria will be the key elements upon which global preferences will be set up [13].

We propose a multi-criteria decision aid (MCDA) model, translated into a Decision Support System (DSS) named "Multi-criteria Methodology to Assess and Select Information Systems/Information Technologies (MMASSITI)". This proposed methodology differs from others in that it already includes the problem structuring phase as a predefined consistent family of criteria (essential, independent, controllable, operational, decomposable, non-redundant, complete, measurable, concise, understandable) applied to an IS/IT selection to be validated and to adjust for the given context to be applied. In this methodology, each criterion has a description and a measure suggested, so that any decision maker (DM) understands the criterion in the same way, fostering the DM's judgment. This initial set of criteria is basically a starting point for discussion; it aims at involving all the DMs, giving them a common understanding of each criterion and helping them to start using the methodology. It also helps the DM to define the family of criteria that will be used in context (from the predefined set of criteria), validating the properties required for this family to be consistent and coherent.

MMASSITI is a DSS that embodies a methodology proposed by Pereira [1], to support the IS/IT selection in an organizational context. It has been designed to be

easy to understand and use, without a specific need for a decision making expert, to offer the DM an effective support decision-making tool and to act as enhancer of the specification accuracy. With this purpose the methodology is simple and guides the group decision makers (GDM) throughout. It is presented "as a check-list" - an exhaustive and coherent family of criteria (shown in Figure 1).

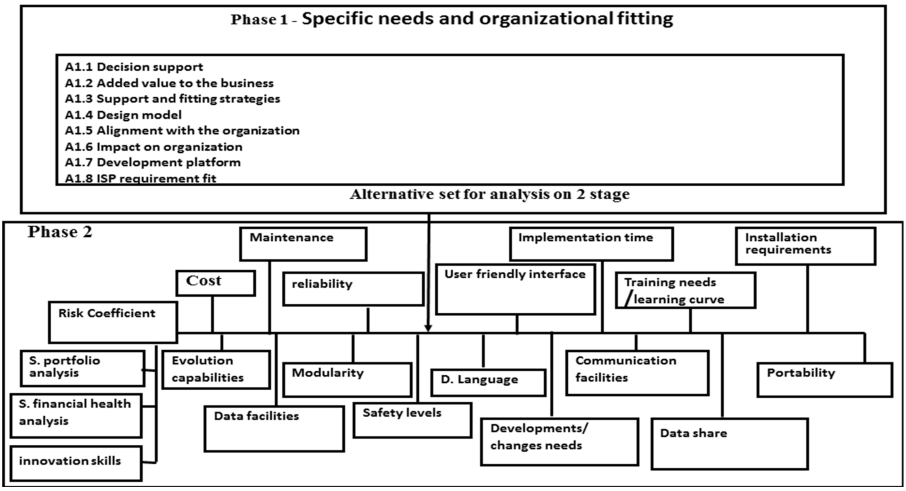

Fig. 1. Multi-criteria Model as an exhaustive family of criteria

This family of criteria does not address a specific IS/IT, but, rather generally covers all the criteria, taking into account the choice of any IS/IT in an organizational context. The intention is to present to the GDM a "starting point" and guides them towards thinking about the importance (or the lack) of a particular criterion to the specific problem and selection scope, whether it is explicitly and fully defined, so that a common understanding exists. It is the GDM that, in the end, defines and validates a consistent and coherent family of criteria for the context to which it is applied, by restricting, modifying, or adding new criteria to the initial family of criteria they are presented to begin with. This consistent and coherent family of criteria defined by GDM should represent all the different and relevant aspects of the problem and should present these properties: independence; measurability; operationality; understandability; and non-redundancy.

As an IS/IT is characterized by its functionalities and entities, which sometimes overlap, the multi-criteria model is divided into two phases: phase 1, concerns macro aspects of the IS and its suitability to the organization strategies, business, resources, requirements and alignment with existing IS/IT; phase 2, concerns micro aspects of the IS/IT itself, such as the technical and functional specifications and requirements. Concerning the decision making problem and the alternatives for analysis, the methodology could be carried out by joining both phases 1 and 2, or with phase 2 only, if the number of alternatives is limited and, at the same time, if all of them match the macro level.

Figure 2 illustrates the model used in MMASSITI, which takes into account all organizational aspects (phase 1 – macro level) and the IS/IT technical issues (phase 2 – micro level).

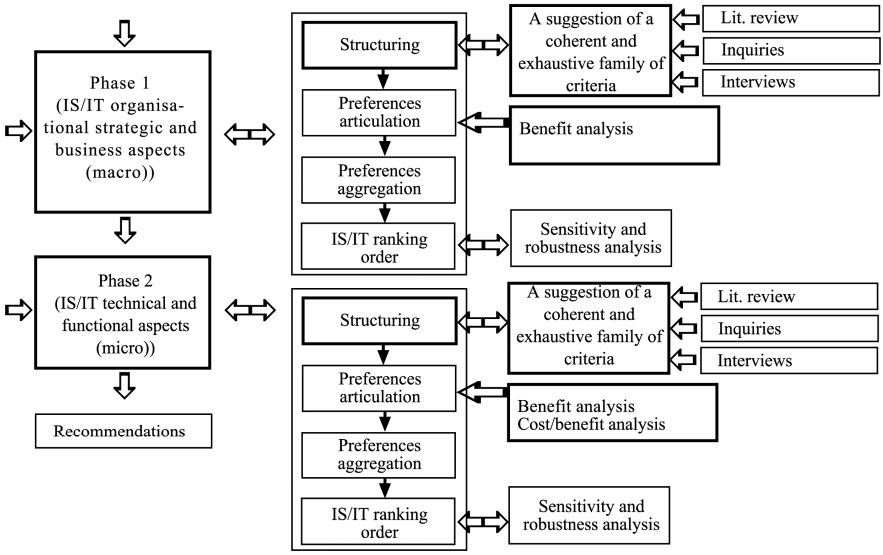

Fig. 2. Multi-criteria Model

Considering these issues, individual preferences must be reduced to a collective preference for group decision making to take place [14 - 16]. Thus, the preference of the GDM is assumed as a collective preference or consensus throughout the methodology.

The MMASSITI DSS performs several steps in sequence, to guide the GDM through the multi-criteria methodology.

- First step: define the consistent family of criteria in consensus with the GDM (to do that a full description and specification of the decision scope must be done);
- Second step: analyze/add and validate each criterion description by the GDM until a consensus is reached;
- Third step: set up the definition of a "neutral" IS/IT and of a "better" IS/IT in the business and organizational context of the analysis;
- Fourth step: set up the collective relative importance ranking (weight) assigned by the GDM to each criterion according to the swing weight procedure [17];
- Fifth step: Define a continuous scale with seven semantic correspondence levels ("Much Worse", "Worse", "Slightly Worse", "Neutral", "Slightly Better", "Better" and "Much Better"). Two of them are reference levels to evaluate each alternative on each criterion: the "Neutral" level and the "Better"

level. The "Neutral" and "Better" level definitions by the GDM are mandatory. This interval scale is fully defined by the GDM. It is a fixed scale that will be applied to all alternative evaluations on each criterion, in both phases.

- Sixth step: Adjust the "Neutral" IS and "Better" IS definition for each criteria.
- Seventh step: Assess each alternative for each criterion. To do so, first the GDM must be aware of the existing information about each alternative per criterion, even if it is imperfect information (such as, ask the providers/supplier of each alternative to do IS/IT presentations and give additional information, to analyze the provider/supplier portfolio, to see, if possible, each alternative in a real context, etc.). Consensually, for each criterion, the GDM must attribute a semantic level to each alternative, taking into consideration the two reference levels, and assign a collective value in accordance with the previously-defined continuous semantic scale.
- Eighth step: Use an additive model to rank each alternative.
- Finally, MMASSITI presents the IS/IT ranking order and respective score value.

MMASSITI also provides to the GDM, a sensitivity and robustness analysis. At the end, the GDM provides effective support for choosing the "best" IS/IT concerning the issues to be addressed and according to existing information at the time.

4 Case Study: SIGE Assessment Analyses and Selection

The case study shows an implementation of a decision aid selection process using the DSS MMASSITI to choose a SIGE from four existing SIGE alternatives on the market, coded A, B, C and D. The information required about each SIGE, to perform the decision aid selection process, was obtained in the region's schools, which use the different SIGEs, and additionally the available information (features and functionalities) on the webpages of suppliers. The multi-criteria analysis was performed only with phase 2 of the methodology, considering specific aspects of the SIGE, since any one of four SIGEs were intended for use in the same context – educational management. This analysis was made by three decision makers.

4.1 Structuring the Problem – Family of Criteria

The definitions of a coherent and consistent family of criteria were produced and some of the predefined criteria of DSS MMASSITI were adjusted and added to the relevant criteria that we thought were crucial to the selection process of a SIGE. Criteria that made no difference to the four SIGE evaluations were deemed irrelevant and therefore not considered.

Seven criteria were selected: cost or licensing of the SIGE; MISI certification (Portuguese ministry of education certification); required functionalities; modularity; web environment; user friendliness; and intuitive navigation (see Figure 3).

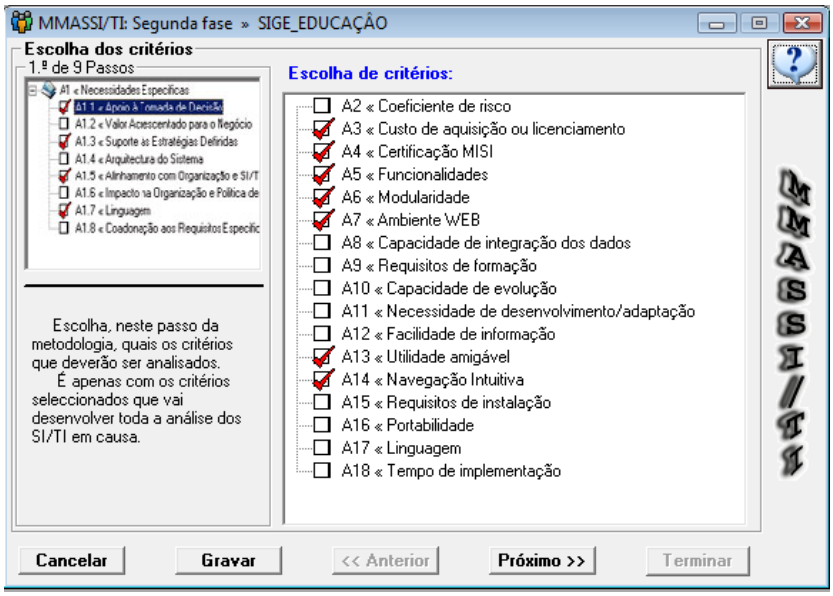

Fig. 3. Criteria definition

Table 1. Operationalization and assignment of weights to the family of criteria

Criteria	Description	Weight
MISI Certification	The entire educational management software has to send information to the Ministry. This process has its own formats. Only the Office for the Coordination of Information Systems of the Ministry is able to assign this certification process	100
Cost of acquisition or licensing	Costs of the solution. Considered as annual licensing and maintenance	90
Web Environment	Solution's ability to operate across the web, whether on an intranet (internal network) or on the internet	80
Funcionalities	Four functional areas with technological support are considered: students; student welfare and social services; accounting; and staff	60
Modularity	Ability to time phase in the full implementation of an integrated solution, in line with the priorities and existing human and financial resources, as each module has well-defined functions	55
User friendliness	Design with aesthetic sense, capable of representing the necessary actions and generate interest by the users	45
Intuitive Navigation	Ease of use of SIGE in obtaining and managing content	40

For the assessment of each criterion of each SIGE it was necessary to create its description (see Table 1), so that decision makers had a common basis of understanding. The criteria were sorted in descending order of importance and weights were assigned using a swing weights procedure [18], both by consensus of the decision makers.

4.2 Articulation and Modeling of Preferences

After the selection of the consistent family of criteria and their ranking, it is necessary to define the levels of attractiveness (see Figure 4), with two of them being mandatory: the "Neutral" and the "Best" levels.

"Neutral" and "Best" levels, respectively, have been defined as: "the SIGE with the basic functionality in school administration and pedagogical areas, with at least a partial MISE certification (one module). Developed in a language that allows them to be used on the web (e.g. using php or asp), with a pleasant aesthetic interface that provides intuitive navigation facilities. Allowing a modular acquisition and with module integration capacity within the same supplier"; and "SIGE with full MISE certification that provides functions across administrative and pedagogical areas, which provide communication services (inside and outside of school), functions in support of the teaching process and learning support service 24 hours for 7 days a week, with navigation facilities and total support, with the possibility of modular acquisition and allowing third-party module integration".

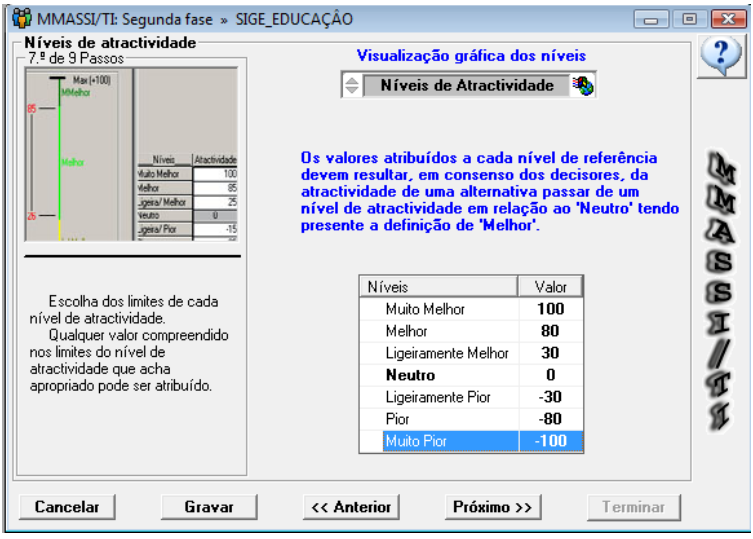

Fig. 4. Valuation levels of attractiveness

4.3 Aggregation of the Valuation of Alternatives for Each Criterion

After the valuation of each criterion of each SIGE, the additive aggregation led to the results shown in Figure 5. The SIGE C was the best ranked with 85.73 points, followed by SIGE B with 24.82, SIGE D with 23.76 and SIGE A with 11.74 points.

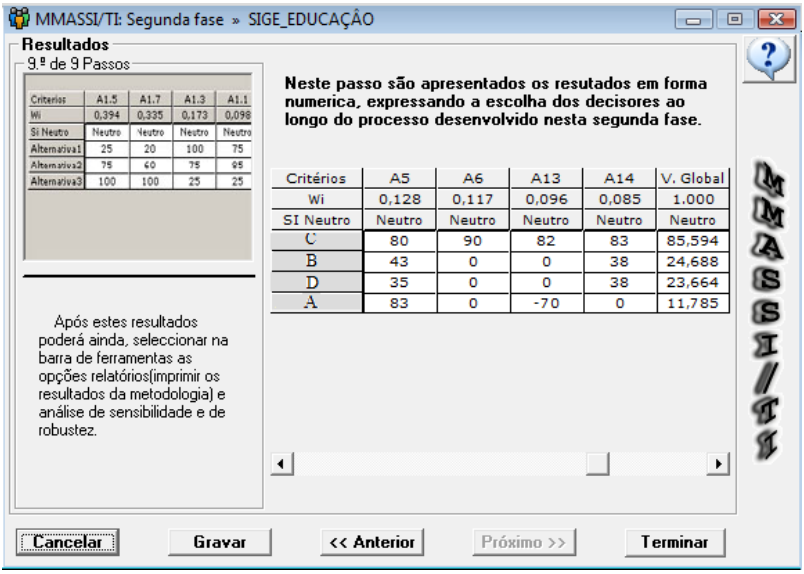

Fig. 5. Aggregation results of each alternative for each criterion

The sensitivity and robustness analysis was also performed to verify the consistency of the results. It turns out that the assignment of weights was equal for all the criteria, not changing the ranking of each SIGE.

5 Conclusions

A multi-criteria analysis translated into the SAD- MMASSITI was used in the comparative analysis of four SIGEs, taking into account: an architectural model framework; the functionalities defined as the ones that an integrated school management system (SIGE) should cover; the information available on the webpages of the SIGE suppliers; and the experience of three decision makers who performed the analysis.

The case study was carried out taking into account the intended architectural model for a real school context but was not specific, needing to cover the present and future reality of administrative and pedagogical school management needs. The valuation, assigned to the alternatives in the analysis, resulted in the classifications of systems, understood as a result of the experience and a quantitative and qualitative analysis of DMs using information available. The aim was to demonstrate that the process of analysis and selection of a SIGE supported by a MCDA, despite the time consumed in the analysis and application of the model, allows the systematization of characteristics and functionalities considered relevant in this kind of system also integrates the priorities of decision makers involved in the evaluation and selection process, making the decision-making process clearer and more objective. In addition, it was found that the SAD used allows the decision maker to systematize the process of analysis, which is particularly relevant when the decision problem is complex.

The special characteristics of the SIGEs, considered at the start of the analysis, forced additional criterion to be incorporated in the SAD-MMASSITI (facilitated by the flexibility of the model) in order to provide a more careful study of educational management support.

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Reorganization and IT Implementation in Campus Management: The Project "PuL" at RWTH Aachen University

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Abstract. Managing tasks accruing in the context of the student life cycle in higher education requires effective and transparent organizational processes as well as a powerful information technology (IT) support. Both aspects are the fundamental components of a university-wide project named "PuL" at RWTH Aachen University. Primarily, the project aims at describing optimized processes in examination and teaching management. In this context, elaborated methods of Business Process Modeling (BPM) are used to create comprehensible and realizable process descriptions. These organizational target processes form the basis for the second objective of the project: the introduction of an integrated supporting IT system (Campus Management System). The final process descriptions supply IT system requirements which are edited in a comprehensive catalogue of requirements. The project stages following this aim to find an appropriate software provider in a tendering procedure and to introduce subsequently the IT system into the organization. This paper will expose the main findings of the project "PuL" at RWTH Aachen University and will illustrate the key aspects for a successful project realization. Focal points are the business process modeling and the requirements analysis which are indispensable for the success of introducing new organizational processes and a new Campus Management System.

Keywords: Campus Management System, student lifecycle, reorganization in higher education, process management, business process modeling.

1 Introduction: The Bologna Process and Campus Management

The efficient and effective fulfillment of tasks accruing in the context of the student life cycle of a university puts high requirements on procedures, services and structures. Students need a broad and full range of services beginning at registration for and attendance of courses, and ending at the completion of examinations at the later alumni status. Rising levels of competition between universities for suitable students especially steps up pressure in favor of excellent general conditions in the field of teaching [1].

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 142–147, 2013.

Considering the German landscape of higher education, it is evident that many universities pursue goals to optimize their offerings and structures in this field. In this regard, it is useful to distinguish between (1) the organizational processes and (2) the capabilities of a supporting information technology system (IT system).

(1) Due to the Bologna process and decentralized organizational structures constituted by autonomous units, increasing complexity in study administration complicates optimal planning, implementation and control of processes in the field of teaching in higher education. On the one hand the introduction of the guidelines within the Bologna process implies more standardization, monitoring and in effect more administrative efforts. On the other hand the conflicting area of tension between the central university administration (the university directorate) and the faculties slows down and hinders decisions and harmonization. This is associated with increased organizational requirements that must be borne by all participants from the central university administration, the faculties and teaching staff as well as students. As an example, the sevenfold increase of examinations that need to be performed is a case in point. Therefore, it is a necessary main objective to uncover and to remedy inefficiencies, ineffectiveness and lack of transparency in the organizational processes at a university.

(2) Because of the quantitative and qualitative complexity of these organizational processes in a large university, supporting IT systems are indispensable. Without support tools, mass actions could not to be mastered, e.g. the registration for courses and examinations, the submission of marks or data management. But the existing heterogeneous system landscape as well as isolated IT applications and shadow systems create inefficiencies, lead to a lack of transparency and coordination, and could thwart the university-wide processes. In this regard, it is a main objective to introduce an integrated system supporting the organizational processes of the whole university. However, limited financial resources require an accurate estimation about which procedures and functions have to be supported by an integrated IT system. Therefore, the definition and weighting of functional and non-functional requirements of a campus-wide supporting IT system is an important process and must be adapted to defined organizational processes.

To meet these challenges, RWTH Aachen University in Germany started a project in order to reorganize processes and to introduce a new IT system. The following sections will present the project, which deals with the aforementioned issues in the context of a single university.

2 The Project “PuL”: Reorganization and IT Support in Campus Management

Based on the scenario introduced in the preceding section, in 2010, RWTH Aachen University initialized a single university project “Prüfungsleistungs- und Lehrveranstaltungsmanagement (PuL)”. The RWTH Aachen University is one the biggest German universities and belongs to leading institutes of technology in Europe. In 2011, more than 35,000 students were registered in 126 courses of studies in 9 faculties. Nearly 5,000 of them were international students. At RWTH Aachen

University about 500 professors teach and do research supported by more than 4,000 scientific employees and more than 2,000 non-scientific employees.

The first objective of the project aims to run an actual analysis to check and reveal the structures, procedures and decision criteria in the three main working fields of the project. These fields refer to the modeling of courses of studies, the planning of courses, and the managing of examinations.

The second objective is to create realizable, sustainable and transparent organizational target processes using existing resources at the University. This aspect includes also the main critical needs of the project: (a) a coordinated discussion within the University about the question on how the processes should be modeled; (b) a specification of the communication and implementation of the target processes; and (c) concepts and methods to measure how the processes will reach the objectives of feasibility, sustainability and transparency.

Finally, the findings from the target processes will determine the implementation of an efficient integrated software solution that will support the execution of the modeled processes.

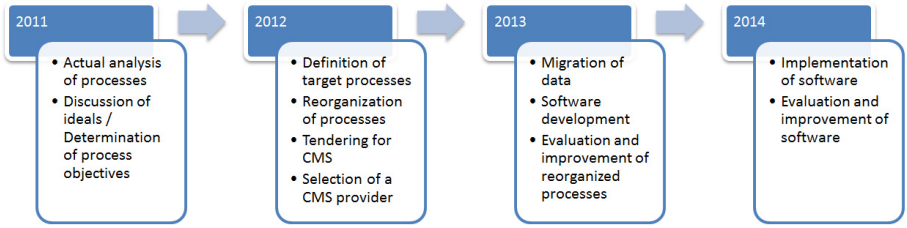

Fig. 1. Planned course of the project "PuL" at RWTH Aachen University (Source: own creation 2012)

Based on these objectives, the project consists of two main working packages: a reorganization using target processes; and the implementation of a new supporting IT system. The approaches and results of these two working packages will structure the project execution as well as the following elements (see Figure 1).

3 Actual Analysis and the Definition of Target Processes

Reorganization aims at the definition, improvement and harmonization of organizational processes. It is an objective to clarify responsibilities for tasks and procedures, to reach more transparency and quality of service and to improve the communication channels. In this respect, the analysis and the modeling of business processes was a main work package of the project [2].

Business processes describe a coherent and completed sequence of activities that are performed step by step and are necessary for the execution of an operational task. While the business process analysis includes the investigation of structural strengths and weaknesses in actual organizational business processes, the modeling forms optimized target processes [2]. For example, in the field of course planning, the analysis reveals the problem of planning without any course overlap and the inefficient distribution of room resources. Representatives of faculties and teaching

staff, the central administration, the Centre for Computing and Communication, as well as students, participated in working groups to create target processes modeled in Business Process Modeling Notation (BPMN) language. The following figure gives a summary of the main business processes (see Figure 2 "Process Map").

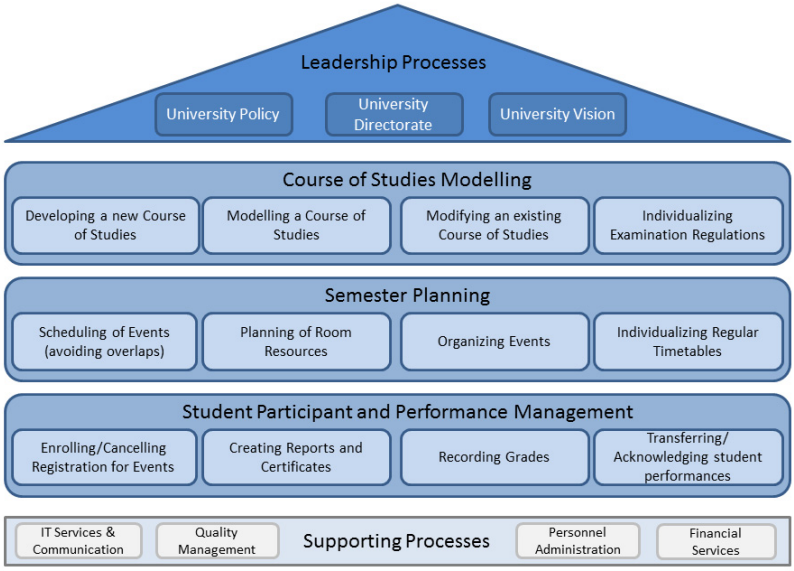

Fig. 2. Process map for examination and teaching management at RWTH Aachen University (Source: own creation 2012)

On the top layer, the leadership or management processes of the university provide a framework for the core processes in the middle of the map. Typical management processes include "Corporate Governance" and "Strategic Management". The base level contains the supporting processes, for example IT services and communication or personnel administration, which are used in all core processes. The operational processes in the middle constitute the core business, and create the so-called "primary value stream": course of study modeling, semester planning as well as student participation and examination management.

The defined target processes are the basis for the reorganization procedure as well as for the implementation of a new supporting IT system. The following section presents the first project activities for the introduction of this new system.

4 The Introduction of a New Campus Management System

A Campus Management System (CMS) comprises all functionalities for managing the student life cycle. A CMS can be defined as an integrated application system offering a single point of data entry and user interface, accessible information in real-time and support for procedures and functions across the board. Additionally, CMSs are

implemented as customizable and modularized standard software and contain all functions for operational activities and business intelligence [3].

The important challenges for introducing a CMS can be summarized by the terms "decontextualization" and "recontextualization". While decontextualization describes the translation from human activities and organizational practices into algorithms and software code, recontextualization considers a second "translation" from formalized activities into the real context of use:

> *"The notion of decontextualization versus recontextualization emphasizes that the challenge of software development is not only writing correct code and providing ample functionality, but integrating new technology into its social and organizational context […]."* [4]

Specifically, procedures of recontextualization require high efforts because of the complex scenarios of use and high expectations of future users [5]. Furthermore, investigations show that weak organizational processes often shift the blame onto IT systems [4]. At RWTH Aachen University the existing IT services and systems make the conditions more difficult; since 2001 RWTH Aachen University operates different systems for managing lectures, courses and examinations which have been constantly developed and extended (e.g. a virtual examination office, and teaching assessment or integration of an e-learning platform based on Microsoft SharePoint). While in 2003 only a few thousand interactions were counted in the first lecture week, the demand grew to nearly 30 million interactions in 2010 [6]. This working IT service landscape increases the user expectation - an important aspect that has to be considered in the project "PuL". These expectations do not only refer to functional requirements but also to quality requirements such as load response, performance and security issues.

With regard to weak organizational processes shifting blame onto IT systems [4], it is essential to apply large efforts to the specification of need for fulfilling and satisfying requirements as well as the mastering of the main challenges - change management (substitution of existing systems and migration of databases) and process mapping (support of process workflows and role concepts).

All aspects mentioned above will be acquired by a Europe-wide tendering procedure. A well-prepared catalogue of requirements containing use cases and functional as well as non-functional requirements aims to find suitable software as well as a cooperative provider.

5 Conclusion and Recommendations

The project "PuL" at RWTH Aachen University aims at improvement and harmonization of processes in the field of teaching in higher education. In this regard, the project combines the issues of process reorganization and IT implementation.

The reorganization is based on a comprehensive business process analysis and modeling to develop suitable and realizable target processes. The target processes determine consistent operational procedures as well as communication channels and responsibilities between roles involved. Additionally, the target processes supply the crucial requirements for a tendering procedure, which is planned for a new supporting

IT system. The successful development and implementation of this Campus Management System will be one of the main future challenges of the project.

First experiences show that it is decisive to invest in professional project management and project communication. Although coordination and communication within the University needs time and effort, it is absolutely necessary to get the critical mass involved. In this context, it is important to consider that there will be probably no minimization of resources. But consequently the reorganization reaches a higher level of transparency, an improved distribution of workload and therefore a higher degree of satisfaction of University staff. These benefits have to be communicated and spread within the University. However, it is very difficult to harmonize the processes. In a University as a loosely coupled expert system, it is necessary to find a balance between top-down decisions and bottom-up approaches.

Furthermore, the differentiation between process reorganization and the implementation of an IT system is important. The introduction of a Campus Management System without analyzing and reorganizing related processes in advance does not work. If the project includes no software independent concept for reorganization the project will face further problems. There will be a big deviation between the scope of system services and the expectations of the users. The missing concept will lead to a missing of the precise definition of objectives and of the project scope. And it will be possible to underestimate the degree of complexity of the project.

Future experiences should be published to give recommendations for other planned projects.

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Part IV

What Educational Management Information Systems Are Already in Place?

Educational Management Systems in Secondary Education in Hordaland County, Norway

Positional Paper

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Abstract. Educational management at the secondary school level in Norway is quite similar for all the counties in Norway. Not only are systems used in secondary education integrated, they are also integrated with many other systems used in government and education at various levels. This positional paper describes these systems and how they work together.

Keywords: Educational management system, school management system, learning management system, integration.

1 Introduction

The goal of this positional paper is to present the systems for educational management used in Hordaland County, Norway and to indicate how they are integrated, from a user point of view. Integration and interfacing of systems should be easy to achieve, but that is far from the situation we experience today. In Norway, we divide educational management systems (EMS) into two categories: school administrative systems (SAS); and learning management systems (LMS). Systems used for school administration contain functions for planning a school year, making schedules. A schedule would include a group of students, a subject and a teacher and in some instances a time and place. The EMS is also where official records are stored; these include semester grades, final grades, examination grades as well as attendance records and behavior grades. A learning management system is used in the classroom to implement the day to day business of education, like assignments and lessons and learning resources. This necessitates integration between the EMS and the LMS.

It is important to have a basic knowledge of the school system and the philosophy behind use of information and communication technology (ICT) in the schools, both for education and management. I start by giving a short description of the Norwegian educational system and Hordaland County. Next there will be a brief description of the major management systems in use followed by an explanation of how the systems interact.

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 151–162, 2013.

2 Norway, Hordaland County and the Norwegian Educational System

Norway is a small country with respect to population, but a very large country geographically with many remote areas. ICT has been instrumental in facilitating equal opportunity and access in all regions of the country, not least of all in education. When you only have a population of 5 million, coordination of data and systems is easy, or at least it should be. National initiatives are relatively easy to implement, ensuring pretty much the same structure which allows us to use the same system or systems with similar architecture, throughout the country.

Hordaland County is one of 19 entities that are separately responsible for education of secondary level students (15 to 18 year olds). Approximately 10% of Norway's population lives in Hordaland County, so we educate approximately 10% of the nation's youth. That means we have about 25,000 students, requiring 3,000 educators and 2,000 to 3,000 support personnel (maintenance, library, administration, etc.). The secondary schools in Hordaland County range in size from 100 students to over 1,000 students. Digitalization makes it possible to give equal education to all students.

There are 10 years of mandatory education, starting at the age of 6. For the first 6 years of mandatory education, the students receive an evaluation twice per school year, but no grades are given. Grades are only given in the last 4 years of mandatory education (in junior high school). The grades are used to rank students when they apply for secondary education (high school) and the grades given in high school are used to rank applicants to higher education (university).

Further education is optional, but all youth have a right to free secondary education, vocational or college preparatory courses. Almost all Norwegian youth complete at least secondary education. The first two years of a vocational education take place in school after which there is a two year apprentice program administrated by the department of education in each county. At the end of the apprenticeship, a journeyman certificate is issued. (A journeyman is a person who has served an apprenticeship at a trade or handicraft and is certified to work at it, for example, an electrician.) There is also a special program where you obtain both college preparatory competency and a journeyman certificate. The two year apprenticeship is particularly useful for students planning on becoming engineers, ambulance personnel or nurses.

Education in ICT in primary and secondary education is called the 5th skill. The 5 skills are: reading, writing, speaking, arithmetic and use of ICT. ICT is not taught as a separate subject. ICT competency is evaluated in each subject, assessing how well the students use the digital aids that are appropriate to the subject. We also have the National Digital Learning Arena whose sole function is to develop digital aids for the subjects taught in secondary school. Many other digital aids from other providers are also in use.

Since digital competency is a part of every subject, even more so in secondary school, students need a laptop available at all times. In Hordaland, we give each student a laptop. We use computers with Microsoft Windows operating system. Our supplier sets up and configures the computers in accordance with requirements we set. Students can freely download, as if the computer were their own. They pay a fee for 2

or 3 years, after which they may keep the computer. The fee corresponds to the grant each student gets from the national government. Other counties have other solutions. Some allow their students to bring their own computer (Macintosh or personal computer (PC)) and, at the other extreme, other counties own and retain full control over the computer and only permit students to download pre-approved applications.

3 Brief Description of Our Management Systems

This section contains a short description of seventeen systems in use. Some of these are used in other areas, not just education. The * indicates a national database.

Residents' Data Base (Folkeregister)*. Folkeregister is the official national register containing (almost) every resident in Norway, with their address. This is "where you come into existence" in Norway. Your birth is registered and you are issued a person number. For non-nationals or immigrants, an application for a person number must be made, and a permanent one is only given if one has fulfilled certain criteria. All students wishing to pursue secondary education need a person number. However, there are many instances where a temporary person number is made up. Typical examples include exchange students or students in the process of applying for asylum.

Almost without exception, the person number is used to synchronize databases. In many instances the person number is used as in the identification data (ID) field of a database to uniquely identify a person. Examples of use are bank accounts, tax records, personnel databases and in this context, our SAS and our LMS.

Curriculum Data Base (GREP)*. The curriculum database is an official code book for education. It contains codes and curriculum information including the structure, study program codes, and course codes for all subjects taught in Norwegian secondary schools. In addition to the codes, the database contains 13,000 competency objectives for the courses taught as well as information on the examination form, number of teaching hours (credits), etc. These codes are imported to our SAS and LMS.

Application for Admission to Secondary Education (VIGO)*. VIGO is a nationally owned system for processing applications to secondary education. It is cordoned off to only permit application to secondary education in the county of residence, with a few exceptions for programs available for students in the whole country.

All application, processing of applications, assignment to a school and program and acceptance functions are electronic. Grades are imported from an SAS at the primary level. The grades are then weighted and assigned a point score. The sum of these points gives a score for overall achievement. This score is used to rank students.

Students must apply for school and a study program every year. They are allowed 3 choices and are guaranteed admission to one of these 3 choices. If they have completed a previous level of a particular study program, then they have to be admitted to one of the following programs from the same study program. It is not permitted to go on to a 2nd or 3rd year of a program until the previous level has been completed.

Processing of applications is a 4-stage process. The first stage produces statistics about how many students have applied for what programs and where. This is used by the county department of education to make adjustments to the offerings at the various schools. If there are few applicants for a program at a particular school, then that program is dropped and those applicants have their application transferred to a school where the program will be held. If there are more applicants to a program than there are places, a new class may be created. The score for overall achievement is used to place students, those with the best grades, i.e. the best score, are placed first choice.

The second, third and fourth stages consist of: ranking students; assigning them to a school; informing them; and the applicants either accepting or declining. This is primarily done by system generated text messages (SMS). Students receive a message containing information on what they have been accepted for. They can either accept the placement or be put on a waiting list for another choice. Students who do not send an acceptance are no longer considered to be applicants. This process is repeated taking into account the new data supplied by the applicants – did they accept, change their priority or want to be on a waiting list. If they are on a waiting list, they can also accept admittance to a lower priority course and still be on a waiting list. The resulting data are exported to our SAS.

At the end of every school year, student progress is loaded into the VIGO system by our SAS. This is used for the next school year, for applying for higher education and to provide statistics for the national government.

Personnel and Payroll (PAGA). Every employee in Hordaland County starts their data trail in this system. It is also used for paying wages and transferring taxes to the treasury. There is a special code that indicates if an employee works at a school or the county department of education. This code is used to key export of personnel data to our SAS.

Student PC Administration (FrontEnd). Each student receives a laptop when they start school. The laptops are set up by the provider, given an ID number in the form of a barcode that is attached to the computer. The PCs are distributed directly from the supplier to our schools in accordance with the number of computers needed.

School Administrative System (Extens). Our SAS is called Extens and is a product developed in Norway. It is based on the Norwegian secondary school system. Any SAS should reflect the structure, functions, laws, rules and regulations of the educational system it is intended to manage. In Norway, education is controlled centrally, that is, the national government is responsible for all levels of education for private as well as public education. Thus the educational system for the whole country is homogeneous.

There are other systems in use in other counties in Norway, but there is little practical difference between them. For this reason, when it became time for a new SAS for secondary schools, the national government deemed it was time for one system in all the counties of Norway. This resulted in a document detailing the user demands for

a new system and tenders have been obtained. Many complex aspects were uncovered and have been addressed.

The SAS has the following "modules": employee information and administration, for both teaching and non-teaching staff; student information and administration; school information and administration; semester administration; examination information; class administration; course codes (national standard) and requirements, both national and local, and administration; student assessment, attendance and behavior including reports; and administration of student PCs.

This system is the hub of all our other systems for use in the schools. This will be reflected in the section entitled "Integration" where the point of perspective considers how this system links and integrates to and from other systems.

System for Schedule Planning (UNTIS). Our SAS does not have a very useful module for schedule planning activities. This necessitates another system being integrated into the mix. Course codes, classes, teachers and students are joined together to produce necessary schedules. This system produces hypertext transfer protocol (http) files that can then be published on school web pages.

Access (AD - Active Directory). Each user is given a unique username and password in our directory (AD). This gives access to a network and an email account. Personnel receive this as a result of being registered as an employee. Students receive this as a result of being admitted to one of our schools.

Authentication (Feide)*. The username and password as well as the person number are sent to a central access function called Feide. Feide makes single sign on possible as a function for all your applications. All end user systems provided by a county or city must use this central sign on system. You can either sign on directly to Feide or you can sign on to one of the applications you have access to. We use Feide for access to our LMS.

Email System for Employees and Email System for Students. Each employee and each student has an email account through Hordaland County. These email accounts are created automatically, directly following creation of a user in our directory. Username and password for logon to an email account is the same as the logon to all other systems.

There are two separate email systems, one for students and one for employees. There are positive and negative sides to this separation. On the plus side, all employees are found in the same email address book, whether they are work at a school or at the central administration. On the negative side, students and only students are found in the student email address book. That makes it difficult for a teacher to send an email to a student and vice versa.

Learning Management (LMS – "Its learning"). We use a learning platform called "Its learning". "Its learning" is also the name of the company that provides the system

and this company is based in Norway. It is the most popular system in use in Norway at the secondary level. The system is in use in countries outside Norway, like the Netherlands and the UK. There are versions for elementary school, secondary school and higher education.

The LMS is used to organize daily activity in the classroom, including courses with teachers and students. Since this information is already contained in our SAS, it is imported as is to the LMS. The teacher can then create teaching plans, activities, lessons, tests and keep track of student progress, effort, behavior and attendance. It seeks to offer everything a teacher needs, every day, for implementation of the goals for a course.

In addition to the functions built into the system, there is an extensive applications library including Britannica Online, Atekst (a digital newspaper archive), NRK skole (television programs from the Norwegian broadcasting agency), NDLA (see the next sub-section), etc. Currently there are 28 applications; some of these require a license fee. "Its learning" has formal agreements with Microsoft and Google so these products can also be used from within the system.

National Digital Learning Arena (NDLA)*. The NDLA was established when the Norwegian counties (all except one) decided to pool a considerable amount of their funds for teaching resources to create digital learning aids for use in secondary education. These resources are open and free to use. They currently encompass general studies courses (subjects found in all study programs) like Norwegian, English, mathematics, social studies, physical education and general science. There are several subject areas for college and university preparatory courses and 9 (of 13 available) subject areas for vocational trades. These resources are available for use from inside our LMS as well.

Documentation of Student Progress (SkoleArena). SkoleArena is a system for documentation of student progress. SkoleArena contains the official record of all work, evaluation, attendance, behavior and examination results. Attendance, behavior and examination results are entered directly into SkoleArena as is the semester grade. Grades for classroom activity may also be entered manually, but our policy is that these grades be registered in our LMS and imported.

Students can log on to this system (or click on a link from our LMS) to see their progress in each of their courses or their attendance and behavior records. Teachers have access to information for the students they have in their class and in the subjects they teach.

System for Examination Administration and for Implementation of Digital Examinations (PAS/PGS)*. Examinations are submitted for evaluation and grading anonymously so this system (PAS) is used to assign a candidate number to each student for each examination they will sit. We have many digital examinations that are standard for the whole country, like Norwegian, English and mathematics. These

examinations are found on PGS. When a student submits a digital examination, it is also evaluated in its digital form. There are 2 examiners for each examination. Each examiner opens the examination and makes their evaluation and sets a grade. If the examiners disagree on the grade, they discuss it and agree on the final grade to be given. Digital examinations save time and money. Sending examination papers through the mail to and from remote areas of the country takes time and is costly, not to mention the risk of losing them along the way. Examination grades are entered in SkoleArena and exported to our SAS.

National Certificate Database (Graduation Certificate/Journeyman Certificate)*. The purpose of the National Certificate Database is to maintain a record of all certificates and transcripts of grades issued from secondary schools. The database goes back to 2000. Our SAS produces a paper copy for the recipient. At the same time, it sends an electronic copy to this database. Journeyman certificates will become a part of this system in 2013.

Application for Admission to Higher Education (Samordnet opptak)*. The system for application to higher education has the same purpose as the system for admission to secondary school. Higher education is university or college education. Those wishing to pursue higher education register their application electronically. All institutions of higher education are included. The applicant registers which school they wish to attend and which course of study they wish to pursue. Acceptance is based on points for performance in secondary school. Certain courses of study require specific subjects and a minimum grade in order for the application to be considered. For example, language studies require the student to have completed the language they wish to study in secondary school; medical students need chemistry and biology as well as mathematics.

Learning Portal (Skoleportalen). Skoleportalen is a website owned and operated by Hordaland County. The tool used for creating templates and publication of pages is Episerver. We provide the schools with a set of master templates that they personalize to fit their own school's needs. Editors are given access to edit their own school's pages through the access system (AD) in the county.

Our learning portal was established in 2000 and has had the same function and appearance since. The learning portal is intended to be an electronic door into schools and activities in the school. These activities include LMS, mail and a pull-down menu with a list of school websites. In addition, there is a rather extensive pointer collection, broken down into the various study programs. It is possible to search the pointer collection as there are meta-tags as well as the study program breakdown.

4 Integration – Not Really, It's Just Import

This section will explain how our systems are integrated or, rather, interfaced. We have no true integrations; we send copies of data from one system to others. Updates

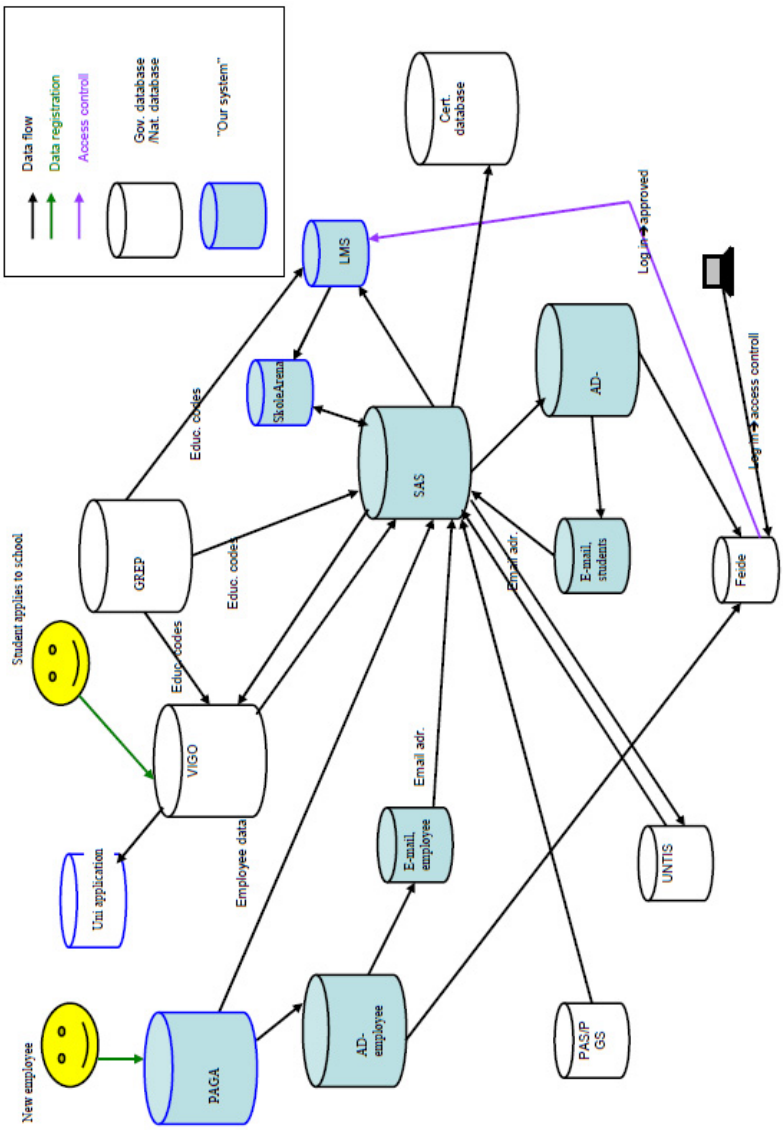

Fig. 1. Interconnections between the educational data systems used in Hordaland County

in the receiving system(s) do not result in updates in the original. When data in the original are changed, they are re-imported. This results in the overwriting of any changes that have been made at the receiving end.

In the following sections, the systems are explained as pairs, with the exception of the first few sub-sections. Since our key system is our SAS, it will be used as a core from which the other systems are described in terms of their connections. At the end, how all the systems are interfaced will be illustrated (see Figure 1).

GREP and Other Systems. One system that is used with many other systems is GREP. GREP is the national code database and these codes are imported to many systems. Many of the systems the codes are imported to allow additions and changes at user discretion. Unfortunately, changes in one system are nontransferable to other systems, causing inconsistency between systems.

The following systems use these codes (note use is independent between the systems they are used in and data flows only one way, from GREP): VIGO (application for admission to secondary education, uses original codes only); Extens (SAS); "Its learning" (LMS); NDLA (digital aids); SkoleArena (documentation of student progress); National Certificate Database (uses original codes only); PAS/PGS (system for examinations, uses original codes only); Samordnet opptak (application for admission to higher education, uses original codes only).

SAS and "Folkeregister". The first pair of systems is our SAS and Folkeregister (resident database).There is no direct connection between these systems, but the person number used in our SAS has to be identical to the one used in the Folkeregister. However, it is possible to register people manually in the SAS when they do not have a person number. In these cases, the number is made up. If a permanent number is issued, the number created in the SAS has to be changed.

VIGO and SAS. Data from the VIGO system (for application to high school) is imported to the SAS, including assignment of school and program of study. At the end of a school year, student assessments are exported from the SAS to VIGO. This is necessary for the next year of application, whether it be for further secondary education or higher education. This is not an integration, but a transfer of data first from VIGO to the SAS and then from the SAS to VIGO.

PAGA and SAS. Employees are registered in our personnel and payroll system PAGA. If they are to work in a school or at the department of education, they are imported to our SAS. The personal data imported to the SAS is complete except for the details of their daily work tasks. The school or department name is also imported to the SAS.

FrontEnd and SAS. Our supplier of student PCs registers each PC in FrontEnd (the PC administration system). The supplier also attaches an ID sticker with a barcode to each PC prior to delivery and distribution. When a student comes to pick up the PC, the consultant accesses the student in the SAS and scans the barcode. All computer

information is then imported to the SAS and it is coupled with the student that will be using it. It also facilitates collection of the fee for using the computer by producing a bill and the student must also sign a contract (or the parents must sign it if the student is under the age of eighteen).

UNTIS and SAS. The next system pair is UNTIS (schedule planning) and SAS. Course information is imported to UNTIS where schedule planning is completed. The plans may then be imported to a school website. Other useful functions included are calculation of workload in order to assure that employees have the same amount of work that they are being paid for and that students have the correct courses and amount of coursework.

SAS and AD. When a student user is created in the SAS, a command goes to the AD (access control) asking it to create a user. The user is created and given a username and password for email, network and various other systems. Employee users are created in connection with registration in the personnel system. When a student has finished high school, a command goes from the SAS to AD with this information. When an employee terminates their position, the personnel system sends this information to AD. The user accounts are put into an inactive status where they remain for a year and a half before being deleted. The username cannot be used again until the inactive user has been deleted.

SAS and Email Systems. Both employee and student email addresses are created by the AD. This happens as soon as a username has been created in the AD. These are then imported to the SAS. The email address could be edited by the user via our SkoleArena, but we have turned off this function. It was necessary to deactivate this function due to incompatibility of the set of symbols and letters allowed in SkoleArena and the SAS. Certain symbols would cause the LMS import to fail and it would fail until the email address was corrected.

SAS and LMS. The next pair of systems is one of the most important. It is between the SAS and the LMS. At the beginning of a school year, all students should have an inactive status in the SAS. This means they are stored away in the trashcan of the LMS. Students that will continue to study are moved out of the LMS trashcan at the start of the next school year. The students that have finished their schooling are left in the trashcan until the period of quarantine is over. This is currently 18 months, after which they are deleted.

All courses from the previous school are deleted in the SAS. This causes them to lose their connection to the structure in the LMS and they are then transferred to the archive where they stay until a teacher retrieves them or deletes them. Furthermore, the hierarchy or structure from the previous year is deleted in the LMS as it no longer reflects the current structure of courses and classes. Some counties keep the structure of more than one school year, but we do not. All deletion from the trashcan in the LMS must be done manually.

At the start of a new school year, the schools make a complete course plan in the SAS. The course plan consists of subjects to be taught, who is taking them, in which

group and who will be teaching them. Classes are also created with a "contact teacher" teacher and all the students. This structure is then imported to the LMS and a new school year is created. Each course and class in the SAS causes an LMS course or class to be created. Changes in students or teachers that are made in the SAS are automatically updated in the course or class groups.

SAS, SkoleArena and LMS. SkoleArena is an interface between the LMS and the SAS. It shows some of the data that is in the SAS. There is additional data stored only in SkoleArena. Some of the data in SkoleArena are concatenated and stored in the SAS. This data includes attendance, behavior, semester grades and examination grades. The fields that are available for direct edit are actually fields in the SAS. Examples of this are email address and telephone number. Most schools have chosen to lock these fields for their students to avoid them registering garbage.

SkoleArena also receives data from the LMS. Our LMS enables all everyday learning activities to be done digitally. This includes tests and course work. The teacher evaluates and comments on the work and sets a grade or approved/not approved status on the work. These evaluations are then exported from the LMS to SkoleArena.

SAS and PAS/PGS. The next pair of systems is PAS/PGS (examination system). Examination data is imported to the SAS. This includes examination codes, student identification (person number), examiner identification (person number) and the date of the examination.

SAS and Certificate Database. The SAS and the certificate database are also connected. Examination grades as well as behavior and attendance are printed out for the student at the end of each semester and school year. This certificate is also sent to the central database from the SAS.

Samordnet Opptak, VIGO and Certificate Database. At the end of a school year, all grades are transferred from the SAS to VIGO. They are then sent to the national government (bureau of statistics). If the student is applying for higher education, the results also go to the system used for application for admission to higher education (Samordnet opptak). Samordnet opptak also uses data from the certificate database.

AD and Other Systems. Our AD (user directory) has many functions. When our AD creates a user, an email account is automatically created. Editors of school websites are given access to their school's website in our AD. The users are then imported to the website and may sign in with their same username and password. The AD is also connected to "Feide", enabling single sign on to 19 applications.

5 Conclusion

No computer systems in Norway can be called "large systems"; there are not enough data records. However, the amount of data is no longer relevant, since storage and

retrieval of data is the simplest part of a system. The largest system is of course the "Folkeregister" with 5 million people registered. The systems are none-the-less very complex and there are many connections that have to communicate with one another. This is where the issue lies; data only flows one-way. The systems end up with corrupt data. Data that was identical to begin with gets changed in one system and the changes do not go back up the line to the source. Sometimes this causes a break in synchronization so transference to other systems down the line becomes impossible.

Glitches in source data create problems in the integrated systems that have to be corrected manually, but you have to find them first. In one instance, a huge amount of "garbage" was sent to our SAS from the national database due to an error they had. The changes in our SAS caused our LMS to try and create 8,000 new courses. Fortunately we had a safeguard on and stopped the import. Had it gone through, all of these courses would have been garbage, but they would have required manual deletion and a quarantine period of 18 months before they could be permanently deleted.

Data imported from the same source to different systems is not always identical in the various systems. The SAS and the LMS import data from the national subject database, independent of each other. Each of these systems allows for supplementation with local goals and evaluation criteria. Since there is no synchronization of this information, this is at best double work, and in the worst case they are not the same. When grades/evaluations are imported from the LMS to SkoleArena, goals and evaluation criteria do not pass over. The teacher then has to go into SkoleArena and connect up the same goals and evaluation criteria that they had available in the LMS.

There are many examples of "where it can go wrong" and it does almost every day. These kinds of errors are time consuming to find and they result in low quality data. For the most part it works astonishingly well. In a perfect world, we would have one central pool of data with applications drawing from it. Unfortunately, our system providers do not have the same philosophy.

Acknowledgements. The author would like to thank: colleagues at Hordaland County for valuable feed back in connection with this paper and the presentation made at the ITEM 2012 conference in Bremen; and Don Passey, Senior Research Fellow, Department of Educational Research, Lancaster University, Lancaster, LA1 4YD for encouragement and help in preparing this paper for publication.

The Ultranet and School Management: Creating a New Management Paradigm for Education

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Abstract. The Ultranet is a form of extranet set up by the Victorian Education Department and designed to allow students to access personalised learning activities and to keep an ongoing record of these activities. It is intended to facilitate teachers in creation of curriculum plans, collaboration with other teachers, monitoring of student progress and providing for convenient student assessment. The idea is also that parents are able to access the Ultranet to see information that would keep them up-to-date with their child's learning. While the Ultranet has many of the features found in learning management systems such as Blackboard or Moodle, it also has many other features intended to inform parents about their child's education and about the school they attend. Powerful tools like this will change the ways that education managers can operate. The Ultranet appears to be one of the first attempts to include all these features in order to inform parents of school children about their school and to provide their teachers with facilities to work collaboratively. The Ultranet is a very large state-wide system involving access to half a million school students (along with their parents and teachers).

Keywords: Ultranet, school management, students, parents, teachers.

1 The Victoria Education Ultranet

In Australia, as in many other countries, parents have traditionally been informed of their child's progress at school through the use of written school reports each term, two or three parent-teacher evenings and perhaps an 'Open Day' each year. As a parent it is natural to want to know what your child is doing at school, and also how well they are progressing. Many parents want to know as much about the school where their children spend so much time as possible, but this is not always easy to achieve.

Learning takes place as a result of every interaction a child has inside and outside the school. We will use the term 'educational environment' to refer to this broader view of education.

Recently, as the result of work by the Victorian Department of Education and Early Childhood Development (DEECD), the Victorian Government conceived an online

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 163–170, 2013.

system, the Ultranet, for informing school communities using web-based technology. This project began several years ago with a report by Griffin and Woods [1] on a "proof of concept student-centric ICT system, called Students@Centre, to support online teaching and learning, curriculum delivery and knowledge management in Victorian government schools" [2]. Their report ultimately resulted in design and construction of the Ultranet, which DEECD describes as "a student centred electronic learning environment that supports high quality learning and teaching, connects students, teachers and parents and enables efficient knowledge transfer" [3]. The $60 million Ultranet, which is essentially an extended intranet/extranet, was rolled out to all government schools in September 2010 [4] when the then Victorian Minister for Education noted that: "The Victorian Government is committed to giving every child every opportunity to experience the full potential of online learning, collaboration and information sharing" and described the Ultranet as the "Victorian Government's biggest investments in information and communication technology in our public education system" [5].

The Ultranet was designed to support knowledge sharing across Victorian government schools and also to provide facilities for informing parents about their child's school, for curriculum delivery and online learning, and teaching activities [6].

The research project described below was commenced in late 2010, but will be on-going for several years as the Ultranet is still in its early stages of use and has not been fully adopted as yet. As there is no compulsion for schools to use the Ultranet, it is not clear which features will be used by teachers and schools, and which will not.

2 Features of the Ultranet

School education in Australia is a state matter and the Federal Government only gets involved in national projects. The Ultranet was designed by the Victorian State Government for use only in Victorian government schools. Time will tell if other Australian State Governments will follow suit. Victoria has 1,555 government schools and 40,000 teachers [7, 8], serving the educational needs of 540,000 students, and their parents. (The State also has 489 Catholic schools and 218 independent schools, but the Ultranet has not been made available to these schools.) All Victorian government schools have government-funded broadband access to the Internet (either via cable or wireless), so high speed access to the Ultranet is not a problem [9, 10].

The Ultranet has many of the features of a business extranet in that security is an important issue and that it is closed to people outside the Victorian government school community and requires a username and password to gain access. A major difference however is in its very large size compared to most business extranets. The Ultranet website [3] notes that this is a 'closed community' with controlled access and that it has a very specific educational purpose as everything that students can do on the Ultranet is intended to support their learning [9].

The Ultranet was designed for three principle uses:

1. To allow students to access personalised learning activities and to keep an ongoing record of these. Students will be able to collaborate with other students from their own school and with students from other Victorian government schools and to create learning portfolios and use online communication tools such as wikis, blogs and discussion boards.
2. Teachers will be able to create curriculum plans, collaborate with other teachers, monitor student progress and provide student assessment.
3. Parents will be able to access the Ultranet to see information that will help them keep up-to-date with their child's learning [9, 11].

Fig. 1. What is the Ultranet? Source: [3]

According to DEECD's website [3] the Ultranet aims to:

- "improve responsiveness to individual learning needs for every student,
- provide better information to parents, schools and the Department,
- improve efficiency of the learning environment and school administration,
- adopt an enterprise approach to intranet development,
- exploit previous ICT investments."

The Ultranet is based on the use of what it calls **Spaces**, which are really mini-websites. It uses icons to help the user to get to the appropriate Space, and **Applications** for use in each space [10]. Each of the different types of specially designed Spaces is intended to allow different information to be accessed and different learning activities to be performed. Each Space is classified by its accessibility into one of the following categories:

- **Me Spaces** (private, and accessible only to the owner),
- **We Spaces** (shared with permission), and
- **See Spaces** (open, public access).

The currently available Spaces are: Home, eXpress Space, Design, Community, Collaborative Learning, Learner Profile, Learning Tasks, My Content and Connect [9].

"**Home** is a personalised page for students, parents and teachers. Users can see school or community notices. Students and teachers can add their favourite applications.

eXpress is a personal space for students and teachers to capture, share and reflect upon their learning. The student eXpress Space includes spaces for their Learning Portfolio and Learning Goals.

Design is where teachers can plan, create and collaborate with colleagues within and across schools. Teachers can use this space to design curriculum and student learning activities.

Community is where students, parents and teachers can find the latest school news and events and get involved in school-based groups, clubs or activities.

Collaborative Learning is where students take part in online learning activities set up by teachers. Students use a range of Web 2.0 tools for learning, including blogs, wikis, message boards and polls.

Learner Profile is where students, their parents and teachers can view a detailed profile of individual learning progress.

Learning Tasks is where teachers can plan, deliver and assess learning activities, and students can view and submit learning tasks.

My Content is where teachers and students can store and search for personal, school and quality-assured digital learning resources.

Connect is where students can find reviewed websites and online activities." [3].

3 School Management Using the Ultranet

Much of our traditional thinking about school management in information technology in educational management (ITEM) has in fact been about administration: things such as attendance records, timetables, test results and learning progress, homework activities and tasks, and teacher feedback. The existence of tools such as the Ultranet enables us to think more about educational management, rather than just about administration [12-14]. Figure 2 shows the relationship between the components of the educational environment that can become facilitated and interconnected by the Ultranet.

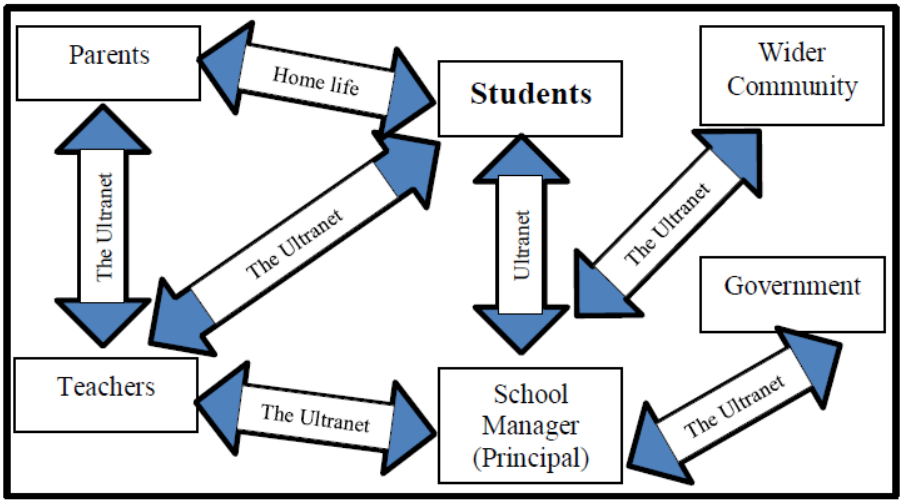

Fig. 2. The Ultranet enhanced educational environment.

A consideration of the potential of the Ultranet has allowed us to identify a number of worthwhile things that can be done. These include [11]:

1. **Communicating Student Progress within the Educational Environment**. Teachers will be able to learn more about individual students through systemic information collected by other teachers. This will allow for more effective personalisation of the learning process and catering for student diversity. Parents will be able to directly learn more about their child's progress but also contribute information back to teachers.
2. **Management of Teacher Collaboration and Professional Development.** The Ultranet may provide an online platform for delivering and monitoring sustainable teacher professional learning, allowing teachers to collaborate, share leading practices and access professional development programmes without traditional space-to-time mappings. It could also provide teachers with opportunities for just-in-time professional learning, trouble-shooting and technical support.

3. **For Managing the Active Involvement of Parents.** Parents, students and teachers could see themselves supported by the Ultranet to create a community-wide educational institution. Students would come to see their education as part of their whole life and family rather than a disjoint time during semesters. This can be problematic as it can result in a reduced face-to-face interaction between parents and schools, but at the same time it offers new avenues for flexible partnerships between teachers and parents, providing opportunities for real-time monitoring of student progress, instantaneous feedback, better alignment of goals and aims between families and teachers which has, in the past, been one of the major obstacles to effective collaboration between schools and parents. Varied levels of digital literacy could also cause concerns as parents with a lack of digital skills may find it difficult to engage with the innovation. This is likely to have a number of adverse effects on the adoption of the Ultranet and could result in widening the gap between those who have and those who have not, initiating further inequalities in the acquisition of social capital and access to digital citizenship.
4. **For Managing Social Networking as New Learning Platforms for Students.** The Ultranet offers a stable powerful technical infrastructure providing opportunities for creating effective local and global networks of learners that can communicate, exchange information and collaborate in augmented realities (real and virtual), allowing for new learning and teaching practices to emerge [15]. The Ultranet could successfully serve this purpose and become a world's leading practice in providing students with an innovative, multi-dimensional eLearning environment. It could provide students with access to experts and learning platforms worldwide and have the potential to revolutionise the learning space deleting the traditional boundaries of classroom walls. This will also change the traditional classroom dynamics and roles, giving students more autonomy, more opportunities for self-directed learning, peer tutoring, and peer and self-assessment. It will also allow students to publish their work worldwide and to establish a track record of excellence. It is unlikely that students will bring in the personal dimension of social networking because of the closely monitored nature of the Ultranet.
5. **Managing the Educational Environment.** The Ultranet has the capacity to create a social network for all those interested in their local school. Parents, teachers and students could be enabled to take an active role. Educational decisions, resource allocation, individual student progress and teacher employment could be the subject of community discussion and decision making [16]. The idea of communities deciding what happens in the detail of schooling forms the basis for several independent schools in Victoria. Some of these matters have theoretically been devolved to local communities in state schools, but the practicalities of democratic decision making normally preclude all but a select group doing the decision making. The Ultranet could provide the platform for community-directed schooling. This again raises the issue of the digital divide. Communities poor in resources and those with low expectation of schooling could suffer disadvantage over a system with minimum standards.

4 Conclusion

In the 1940s Thomas J. Watson (Chairman of the Board of International Business Machines) is reputed to have said that the world would have a need for only about five computers. In the 1950s a computer user was a 'white coated scientist' writing computer programs in machine or assembler code and feeding data into a mainframe. The invention of the PC offered a tool that has meant that the user is an 'everyman', using a computer in a plethora of ways and for many different purposes. In education, the current manager is constrained by the tools available to manage locally within school buildings. A tool like the Ultranet removes the restriction of locality and communication. The school manager now has the responsibility, and the ability, to involve all elements of the educational environment and not just those on the old communication lines.

Parents can now be seen as an educational resource and not just as an arms-length client. Each parent has significant information on a daily basis about their child. An open and facilitated communication between the parent and the school means that this information can be utilised and not just overlooked. Parents can now be kept informed about ways in which they can contribute to their child's learning. To take advantage of the Ultranet in this way, however, the school manager must revise their view of the role of the parent.

The management of teacher professional development often appears to be very haphazard in an industry supposedly devoted to education. While some formal learning activities are provided to teachers, the informal education that forms the majority of professional development in other professions is largely absent. An educational manager is tasked with keeping individual classrooms supervised rather than worrying about a bigger picture. The Ultranet encourages asynchronous communication between teachers and between schools, and this removes the impediment of time and location from collaboration within a discipline.

A school exists in a community rich in human resources: people with industrial experience, the elderly, local professionals, work settings, factories, shops, hospitals and community bodies. While in the past it has been very difficult for schools to utilise these resources, as a social network the Ultranet facilitates ready communication and easier management.

The task of the new educational manager with a tool such as the Ultranet is thus to think of their role in the wider educational environment.

The Victorian schools Ultranet commenced operation only in September 2010 and so far not all teachers and parents are fully supportive of its operation. The need to inform parents of school children about the child's school and educational progress is something that governments and education authorities have always acknowledged. Technology like the Ultranet offers new ways to do this and should appeal to the 21st century parent. The Ultranet can be seen to offer many possibilities for informing parents about what their children are doing at school and about their progress, as well as informing parents about the school itself. Some people, however, question whether parents are ready for information of this type. The Ultranet offers possibilities for useful interactions of many types between all members of school education communities, but some again question the value of such interactions. Time will tell whether the Ultranet turns into something really worthwhile or just another government White Elephant.

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Pupils' Data

Implementing a Management Information System to Optimise Planning in Berlin Schools

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Abstract. Parents are able to choose the school their children will attend. Thus, a core task of the Berlin Senate Administration Office for Education, Youth and Science (SenBildJugWiss) is having optimally-resourced schools with the adequate number of teachers at the start of a school year. The project's mission was to obtain accurate figures by efficiently processing data of approximately 320,000 pupils from 700 schools. This processing included reporting on the various target groups of the SenBildJugWiss. The solution was to implement the OLAP-Database Palo as a management information system (MIS) tool. By doing so, it was important that an initial version was completed fairly swiftly to demonstrate main functions for future users, to highlight necessary adjustments for integration into the existing system, to define key performance indicators (KPIs) and their data sources, as well as creating the desired reports. One of the major challenges was creating a homogeneous data structure and harmonising the search and query language (SQL) tables. The outcome is a MIS that best fits the requirements, including meeting strict data protection regulations. The created reports provide, inter alia, the data delivery status required - the amount of pupils per class and schools eligible to gain certain levels of resources.

Keywords: Information management system, educational management, planning optimization, pupil data.

1 The Problem

1.1 The Initial Situation

As a result of the School Structural Reform, parents are able to choose the school their children will attend. Thus, a core task of SenBildJugWiss is having optimally resourced schools with an adequate number of teachers at the start of a school year.

Resources are planned by analysing detailed pupil data [1]. Unfortunately, these analyses only deliver deficient and unreliable information due to a heterogenic IT-system and a lack of IT-integration with some departments of the SenBildJugWiss. Therefore, despite being available in SQL-data bases (DBs), it was not possible to aggregate the relevant data efficiently. Depending on the know-how of individuals, analyses were carried out using MS Excel. Consequently, interdisciplinary reports were either sparsely accessible or took a long time to be created [2].

D. Passey, A. Breiter, and A. Visscher (Eds.): ITEM 2012, IFIP AICT 400, pp. 171–176, 2013.

1.2 The Legal Framework

The Berlin Data Protection Act, Berlin Education Act, and Berlin School Act. There are numerous legal data protection regulations that fundamentally affect both the design and functionality for software components of an IT platform as well as corresponding SenBildJugWiss organisation processes. Details for automating search of personal data as well as adhering to technical standards are defined in Paragraphs 64 to 66 of the Berlin Education Act [3] and in the Berlin School Act [4], containing, inter alia, the following details:

- Legitimacy for pupil data processing in automated files, possible data to be collected and the point of time of their erasure.
- Functions responsible for data processing.
- Spatially separating personal computers (PCs) used for analysis from those used for lessons.
- Depersonalising specific pupils' data categories already entered by the schools using a software tool.
- Administering an automated pupil DB in SenBildJugWiss using unique indices instead of pupils' names (pseudonymisation).
- Authorisation for searching for pseudonymised pupil data.

When processed automatically, the data is separated according to its purpose and is done in such a way that only respective authorised personnel can access it [5]. Furthermore, there are detailed requirements for maintaining data processing systems; thus, the Data Protection Officer is an important stakeholder [5].

The Berlin Employee Representation Act. This act contains details of tasks relating to specific employee representatives. The Women's Officer and the Representative of Disabled Persons are among them [6]. The following clauses (amongst others) needed to be applied in the project:

- Paragraph 79: The duty to obtain consent from employee representatives regarding measures of the SenBildJugWiss.
- Paragraph 59: The participation of the Main Personnel Council, especially in IT projects.
- Paragraph 74: Conclusion of a works agreement. This is a helpful tool that formally documents permission to execute the project and records details that have been agreed regarding the procedure [6].

In view of the above, the chairman of the Main Personnel Council is one of the most crucial stakeholders.

The SGB IX- Rehabilitation and Participation of Disabled Persons and Berlin Equality Act. The Representative of Disabled Persons is empowered by Paragraph 95 of the SGB IX [7]. The Women's Officer acts according to Paragraphs 16 and 17 of the Berlin Equality Act [8]. Paragraph 3 of the Berlin Equality Act requires active contribution to an equal proportion of both genders in professional functions which, of course, applies to this project too.

DIN EN ISO 9241 and Workstation Regulation. DIN EN ISO 9241 requires user-friendly software design, and workstation regulation ensures access and use of ergonomic hardware equipment.

2 The Project "Pupils' Data"

2.1 Mission and Objectives

The mission of the project was to:

- Digitalise data of approximately 320,000 pupils from 700 schools.
- Efficiently automate processing and analysis of this data for delivery of figures to SenBildJugWiss.
- Create a reporting system in the context of business intelligence, i.e. implementing a MIS in the existing IT system.

The objectives were to:

- Improve planning.
- Optimise use of resources: teachers and budget.

The project was undertaken by a range of team members. The team members and their functions are described in Table 1.

Table 1. Project team members and their functions

Role in the Project Team	Function
Project Leader	• Head of Department "eGovernment@School" SenBildJugWiss • Overall responsibility for project management
Project Coordinator	• Department "eGovernment@School" SenBildJugWiss • Organisation of communication
Project Officer	• Department "eGovernment@School" SenBildJugWiss • Planning and managing the project, focusing on data protection
Project Consultant	• 2k Consultants (external) • Project expertise in the public sector, including knowledge on developing a data warehouse, implementing business intelligence using Palo in the public sector, monitoring and identifying KPIs • Interfacing with the software provider Palo-DB • Supporting project management
Data Protection Expert	• Data Protection Officer SenBildJugWiss • Ensuring data protection adherence
IT Experts DB System Management	• Head of IT and another IT employee of the Department "eGovernment@School" SenBildJugWiss • Integration of the Palo-DB into IT systems including ensuring correct interfaces between systems using lightweight directory access protocol (LDAP) within data protection (user access management, and authentication)
IT Expert Data Warehouse	• Department "eGovernment@School" SenBildJugWiss • Process implementation, and report design • Future internal capacity to use Palo
Software design	• Jedox AG (external) • Designing Palo OLAP-DB

3 Realisation of the Project and Results

3.1 Design

The project began by creating a test environment for executing trials isolated from the operating system. This test environment has been permanent and will also be used for making any further changes to the Palo-DB. Furthermore, a pilot version of the Palo-DB for explorative prototyping [9] was created. Due to information gathered, a prototype was developed and was also examined in the test environment. After having achieved satisfying results, the trial underwent live operation in some departments of the SenBildJugWiss. The roll-out for all users was planned to start after successful completion of the trial.

3.2 Information Flow

Preparation of Data Imports into Palo-DB from Schools. As authorised personnel, head teachers enter the data into an MS Excel file. A special software is then applied that verifies the completeness of the data and changes the MS Excel files into two common separated values (CSV) files in order to anonymise the data by separating them from any identifying attributes. This software was especially developed for this purpose by the Fraunhofer Institute. Both files are sent via an encrypted e-mail to the person responsible at the SenBildJugWiss.

Preparation of Data Imports into Palo-DB from SenBildJugWiss. Before the files are used, the person responsible authenticates the sender e-mail via sender certificate. The two CSV files per school are imported into two separate SQL-DBs. These files are copied to another server belonging to the SenBildJugWiss. The names of pupils are replaced with unique indices.

Data Import into Palo-DB. The Palo-DB is opened. The now anonymous data in SQL format, further MS Excel and SQL files are manually linked to the Palo-DB. All necessary data from these files are loaded into the Palo-DB, which is stored on a SenBildJugWiss server. The date when data would be used was determined during the project. Subsequently, defined reports are able to be created by permitted users via the cockpit (user interface) of the DB.

User authorisation for the Palo-DB is managed using the user access system of the SenBildJugWiss-server. Access rights are administrated using their central directory service. To ensure unity, roles were set up identically in the Palo-DB and an interface was programmed using the LDAP standard. Furthermore, the administration of new passwords and user permissions is not applicable. The user can only access data according to the respective rights of the schools or district.

3.3 Available Reports

Users of the currently-created reports are the IT Centre of Competence, the 13 educational authorities, the twelve supervisory school authorities (as of March 2012), and

Table 2. Available reports, KPIs and query functions

No.	Report	KPI	Query dimension
1	Delivery overview	Total pupils Pupils who are "Exempt from Purchase of Teaching Materials" (EPTM) or Non-German origin (NGO) Number of classes Average class sizes Values from the previous year	Federal state, district, school
2	Delivery status	Delivery status per school Comments may be entered	
3	Delivery status detail	Delivery status per delivery per school	Deliveries 1- 4, district
4	SenBildJugWiss tuition supply	Pupils who are EPTM and NGO	District, school
5	Pupil data	Status of forecasted number of pupils: Total, additions, those changing schools, leavers, unchanged status, unknown status for change from secondary level (SEK) I to SEK II Pupils per school type Pupils per focal point of support Pupils per delivery date Contact data of schools Values from the previous year	Status Type of school Type of focal point of support Delivery date 1- 4 District, school
6	Pupil data with classes	As report 5, but without "Pupils per focal point of support" and "Status" Number of classes Average class size	District, school, class level

the head teachers from all 700 schools. Table 2 shows the available reports, the KPIs and the dimensions that can be interrogated using filters.

4 Discussion and Future Prospects

All data protection requirements were met by the project. The Palo-OLAP-DB processes approximately 3.5 million pieces of data at a high calculation speed.

The system can also be run on a server with a memory of 4 gigabytes. The DB works solidly and plausibility tests have yielded accurate calculation outcomes. The control cockpit at the front end for end users is found to be user-friendly. Required information can be retrieved via a mouse click and without intensive training being necessary.

By requiring local authorities to supervise schools, the essential KPIs for optimal resource decisions are now currently available. As a result, KPIs are created from cross-functional data sources due to linked files from various departments. Thus, a further outcome of the project is that it contributes to an improved interdisciplinary collaboration. Based on role-defined access to pupil data, the Supervisory School Authorities (responsible for school buildings, districts and for teacher resourcing) are able to coordinate more quickly with each other.

Live operation for further users is planned via a web solution. Further modules can be added to the existing solution using the same IT infrastructure in order to gain further efficiencies across the various educational administrative authorities in the Federal State of Berlin.

Acknowledgements. This is a sub-project of the wider "eGovernment@School" project of the Berlin Senate Administration Office for Education, Youth and Science, run in collaboration with 2K Consultants.

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