Datalogging

Datalogging in Singapore Schools: Supporting effective implementations

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Abstract

This paper reports the findings of a national survey on the use of dataloggers in secondary schools (Grades 7-10) and junior colleges (Grades 11-12). In particular, it explores the types of learning activities that teachers conduct using dataloggers, the support structures they deem necessary, and the difficulties they face. Out of the 593 respondents, 394 (67%) had used dataloggers in the last two years, mainly in demonstrations and set experiments. The three most important support structures included: supportive laboratory technicians, training on the use of dataloggers, and instructional material on how to use dataloggers within the curriculum. The difficulties which deterred the respondents from using dataloggers included the logistics and time taken to set up datalogging equipment and activities, insufficient numbers of computer workstations, and the mishandling of equipment by students leading to equipment malfunctions. To expand the use of dataloggers in school, the respondents suggest that dedicated laboratories be set up for datalogging activities, more curricular material to support datalogging be prepared, more familiarisation courses be run for teachers and laboratory technicians and, in particular, how dataloggers fit within an inquiry science learning approach.
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Introduction

Datalogging methods involve the use of electronic sensors and interfaces to measure and record changes in variables during experiments, for example, temperature and pH. Data are automatically collected and can be displayed in real-time in the form of tables and graphs on a computer screen. This use overcomes the time lag between the experiments and the graphs which students would plot manually, and which are often seen as separate entities by students (Barton, 1997a). The most recent datalogging software also supports sophisticated analysis and transformation of data and graphs. Thus, datalogging frees students from taking complex measurements, tabulating data, drawing graphs by hand, and executing complex calculations (Osborne & Hennessy, 2003) in order to tackle more conceptually demanding tasks such as the planning of experiments, and in particular, the analysis and interpretation of data (Barton, 1997b; Newton, 2000; Rogers, 1997; Rogers & Wild, 1994, 1996). The benefits of datalogging depend on the quality of students’ thinking about the experiment and data, for example, asking questions about data, making links with other information, making comparisons and prediction, and looking for trends. Therefore, the real-time information on the experiment provided by the dataloggers and the tools provided by the associated software are of little benefit if the students watch the screen uncritically while the data are being tabulated and graphs plotted (Newton, 1997; Roger & Wild, 1996). In addition, the range of questions that can be investigated and amount of data that can be collected expand as
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dataloggers support measurements of transient phenomena, as well as longer term monitoring of variables (Osborne & Hennessy, 2003; Singer et al., 2000).

However, schools do not seem to be embracing the use of dataloggers; Roger and Wild (1994) reported that National Council for Educational Technology survey in the United Kingdom showed only 11% of schools used datalogging for more than 3 hours a year, 54% made some use, and 35% reported no use at all. More recently, Newton (2000) studied the use of dataloggers in four secondary schools in the United Kingdom and found that they appeared to be under-used despite research findings identifying their benefits. The teachers interviewed by Newton saw datalogging as a means of providing students experiences with present-day technology, providing opportunities to tackle more demanding tasks and more control over the management of the experiments. However, the teachers were realistic about the use of new technologies in science education. Newton found that equipment failure and technical difficulties were the main obstacle to successful use of datalogging, and made datalogging lessons more risky for the teacher than conventional activities. The teachers also commented on the need to have enthusiastic and experienced colleagues to lead and support the use of datalogging, and the need for datalogging activities to be developed and written into schemes of work to encourage teacher use.

Dataloggers were introduced in Singapore schools under the first IT Masterplan (1997-2002). Secondary schools (Grades 7-10) and junior colleges (Grades 11-12) were given six sets of dataloggers for every laboratory that the schools have. Training on the use of dataloggers was provided mainly by the equipment vendors, with the Educational Technology Division, Ministry of Education, Singapore, providing several follow-up workshops on the integration of dataloggers into the curriculum subjects. Following informal reports that many dataloggers were not being used frequently in schools, this study was initiated in December 2003 to study the implementation configurations, efficacy and teacher
use of dataloggers in science lessons. During the same period there had been other interdisciplinary initiatives which were emphasising student experimentation and project work, and the study was also conceived as an opportunity to explore how many teachers saw potential overlaps and symbiotic relationships for using the equipment to develop inquiry science projects. This paper describes some of the results obtained from the survey of science teachers in all secondary schools and junior colleges, and explores the implementation stage at which each teacher saw themselves, either as current users, past users or non-users. It also explored the pedagogical approaches of the teachers towards the use of dataloggers in practical and project work, the support structures they deemed important, and the difficulties they faced using dataloggers in their lessons.

The online survey questionnaire

The questionnaire asked each respondent to identify themselves as either Head of the Science Department (HOD) or a science teacher and then describe their use of dataloggers in the school. The questions focused on:

1. their teaching experience,
2. whether they currently used or had used dataloggers in their lessons,
3. if they had used dataloggers, the subjects and topics in which they used dataloggers,
4. the types of learning tasks involving dataloggers,
5. the teacher’s role in datalogging activities,
6. the pupil’s role in datalogging activities,
7. how pupils were prepared to use dataloggers,
8. whether pupils were able to interpret data,
9. whether inquiry-based activities were conducted, and if so, how the inquiry-based activities were conducted,

10. the support structures their school provided for datalogging learning activities, and

11. any difficulties they faced in conducting datalogging activities.

In the discussion, we distinguish between the data profile of current users, past users and non-users of dataloggers, the types of tasks for which dataloggers were used, the support structures which the respondents deemed necessary, and the difficulties that the respondents believed they faced in conducting datalogging activities.

Two pilot studies involving open-ended questions were conducted, involving a total of 22 teachers from five secondary schools and 11 teachers in professional development graduate programmes at the National Institute of Education, Singapore. After the items were finalized, the survey was posted on the website for general access. Examples of the items in the online questionnaire are given in the Appendix. The options for the multiple-choice items in the questionnaire were derived from the data obtained in the two pilot studies. A majority of the items allowed the teacher to select more than one choice to capture, for example, the various ways the teacher used dataloggers in class activities. Many items also had an ‘others’ option which allowed the teacher to provide any response which was not included in the options given. The free-response questions allowed the teacher to elaborate on more specific situations and issues, for example, why the teacher had stopped using dataloggers, the difficulties faced by students using dataloggers, and how the teacher helped the students to overcome any difficulties.


**Implementation of the online survey**

Letters and emails were sent, in July 2004, to all Principals and Science HODs in secondary schools and junior colleges, explaining the objectives and nature of the research project, with a request that six teachers, including the HOD, complete the survey. A total of 175 HODs and 875 science teachers from 175 schools were invited to participate in the online survey. After five weeks, when the online survey was closed, a total of 114 responses from HODs (65.1% of the target) and 479 responses from science teachers (54.7% of the target) were received. The overall response rate to the online survey was 56.5%.

**Some survey findings**

Final responses were obtained from 151 out of a total of 175 schools. HODs and science teachers from 14 junior colleges (total 17), 7 independent schools (total 8), 19 autonomous schools (total 24), and 111 other secondary schools (total 126) participated in the online survey. Independent schools are schools which have autonomy to admit students, and implement school programmes and administration. Autonomous schools are government schools which have a greater freedom to provide a wider range of innovative and enrichment programmes. Schools in the ‘other secondary schools’ category are normal government schools. The breakdown on the respondents in terms of schools, designation and subjects taught is given in Tables 1, 2 and 3. The highest response rate came from the junior colleges and independent schools though the number of such institutions are two smallest among the four types of schools.

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Tables 1, 2 and 3 about here

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Profile of users, past users and non-users

In the questionnaire, users were defined as people who used dataloggers within the past two years, past users were those who had last used dataloggers more than two years ago, and non-users were those who had not used dataloggers at all. Tables 4, 5, and 6 show the profiles of the various types of users.

The independent schools had the highest percentage of users (90%), and other secondary schools the least (61.3%). The percentage of past users was similar for junior colleges (14.7%), autonomous schools (14.1%) and other secondary schools (16.7%), with independent schools having the lowest percentage of past users (3.3%). There were more non-users from other secondary schools (22.0%) compared to the other schools. The percentages of HODs and teachers who were users, past users and non-users were similar (see Table 5). The percentages of users in the two most experienced groups of teachers, with 16 to 20 years (75.4%) and over 20 years (75.7%) of teaching, were higher than that of the least experienced teachers, those with less than 5 years of teaching (57.5%). This finding was surprising as younger teachers were expected to be more aware of information technology (IT) and be more adept using it. In addition, younger teachers had been introduced to using dataloggers in the science pedagogy modules in their professional preparation. One HOD remarked that a possible reason for the finding was that the less experienced teachers were still adjusting to the administrative and curricular demands of their schools, or were unaware of the resources available in school so that they did not explore the use of dataloggers in their lessons. This is reinforced by several responses stating that there was little time for
Datalogging because of the need to complete the syllabus and that the equipment was not readily available. The more senior teachers would have undergone training on the use of the specific brand of dataloggers given to the school by the Ministry of Education (MOE) or bought by the schools; the less experienced teachers were less likely to have had this specialist training, and correspondingly might be less confident using the dataloggers in their schools. Thus, the difficulties of accessing the equipment and the demands on younger teachers to cover the schedule of work within a certain time frame might have them concentrating more of the “content” and less on the processes of inquiry science. Comments by non-users (mostly younger teachers) about not using dataloggers and why they did not see any potential for the use of dataloggers included:

“It’ll probably be a one-off thing that takes too much time for pupils to master the use of apparatus and equipment.”

“Do not have time. Have to complete the syllabus.”

“Tedious, time-consuming to set-up, prepare for lesson. Limited time in class to explain how to use or how to interpret data.”

“Not for practicals – very difficult for dataloggers to be incorporated into school-based practical assessment.”

“It is cumbersome and unreliable. The effort to set up and debug is more of a waste of time.”

“Not enough PCs. If we do group work or collect data remotely, we still need PCs to analyse the data.”

Time to deploy and setup, equipment access issues, perceived lack of relevance to the syllabus and scarcity of computers in the laboratories discouraged the non-users from using
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dataloggers. However, 74 of the non-users (81.3%) still believed that there was some potential for using dataloggers, in areas such as demonstrations, project work and for enrichment.

Past users were asked why they stopped using dataloggers (see Table 7). The main reason given was the lack of time (47.3%) to prepare, set up and carry out datalogging activities, and the pressing need to complete the planned work schedule. Past users also had difficulties with the shortage of computer workstations in the laboratory, the setting up of datalogging activities and the troubleshooting of faulty equipment (35.1%). In addition, some found incorporating datalogging into the curriculum daunting (16.5%), giving reasons such as the lack of relevant datalogging activities in the syllabus, especially in the School-based Practical Assessment (SPA) which was designed to support the experimental skills in learning science. The equipment- and curriculum-related issues were similar to those highlighted by the non-users, and to those reported by Newton (2000). The lessons for school administrators here are certainly the complexity of access and activity setup that effectively destroys the teacher’s desire to use the technology in anything more than a demonstration.

Table 7 about here

Past users were also asked if they would use dataloggers in the future, most (81.3%) replied that they would. Several of them confirmed the findings from the non-users as they insisted that certain changes or improvements would need to be first made to the organisational contexts in which the dataloggers were being used. These included having more time, sufficient numbers of computers in the laboratory, datalogging equipment permanently set up in the laboratory, and laboratory technicians who could set up the
Datalogging apparatus with minimal supervision to support quick use within constrained lesson times. Seventeen past users (18.7%) were so disenchanted that they would not consider using dataloggers in the future at all. However, several of them stated that they would use dataloggers if their students wanted to undertake a project, or if worksheets and lesson plans were easily available.

Uses of dataloggers

The most common lesson use of dataloggers was in demonstrations and experiments (see Table 8). Experiments generally refer to the set activities which were included in the schools’ schemes of work. The percentage of all users (users and past users) who either used dataloggers for demonstration or experiment, or for both purposes is 82.4%. Dataloggers were used to a much lesser extent in fieldwork or project work, enrichment activities and for co-curricular activities (CCA). Overall, dataloggers were used more for teacher-centred or teacher-directed activities rather than for student-directed investigations. The percentage of users and past users for each type of use followed a similar distribution except for their use in set experiments (61.2% for users, 35.2% for past-users). These set experiments which were written into schemes of work invested them with status (Newton, 2000), made explicit the curriculum and datalogging links, and thus, were useful in supporting the use of dataloggers as part of the students’ learning experiences.

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Table 8 about here

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Support structures

Respondents were asked to rank which support structures were necessary to support their use of dataloggers in their lessons and to indicate any support structure which they found lacking in their schools or any of the courses offered. The results are tabulated in Tables 9 and 10. Overwhelmingly the requests were for others to support them deploy the equipment.

Laboratory Staff Support. Laboratory technicians or assistants, who can help the teacher set up the experiments employing dataloggers, troubleshoot technical problems, calibrate sensors, and maintain the datalogging equipment, were regarded as the most important supports, which mirrors a similar finding in the United Kingdom (Newton, 2000). Without the laboratory staff support, teachers believed that the time and effort to use dataloggers was not commensurate with the learning gains that might be obtained. Nearly 18% of the respondents believed that laboratory staff support was needed in their school (Table 10). However, cross-tabulation of data indicated that 36.0% of the 50 past-users who ranked laboratory staff support first, second or third in importance, indicated that they also felt that laboratory staff support was lacking in their schools and this should be compared with 23.2% of current users who felt that this was an issue. Thus, the ready availability of laboratory support staff who were proficient in the use and maintenance of dataloggers would be a major incentive for teachers to use dataloggers (Newton, 2000).

Importance of Training in Using Dataloggers. Training on how to use dataloggers was ranked the second most important support structure but only 14.0% of the respondents
considered that it was lacking. Training had been provided by the product vendors when the
dataloggers were first distributed to the schools; however, many teachers who were posted to
schools after the initial roll out of the equipment, had missed the initial training sessions.
Teachers also tended to forget how to use the dataloggers if they did not use the dataloggers
regularly. Forty respondents indicated that they wanted training on how to use the
datalogging sensors and software (see DY22, Appendix). Their comments included:

“Because we do not use data-loggers so often, we tend to fumble and need to read up
again in order to be familiarized. Refresher training is essential.”
“Hands-on training or refresher workshop from time to time.”
“How to calibrate some of the sensors and superimpose graphs onto one another using the
software provided.”
“How to troubleshoot the datalogger apparatus in case it does not work.”
“How to use the sensors for accurate measurements. How to take care of the sensors and
equipments. How to calibrate.”

Appropriate Training by Vendors. As different brands of dataloggers were given to
schools in the various implementation phases, it might be expected that the vendors would be
better suited to provide such technical or refresher courses. Ten respondents suggested that
training should also be provided to laboratory technicians to help teachers set up the
datalogging activities and to troubleshoot technical problems. One teacher made the
comment, “Courses by vendors/service providers/institutes are really useless as they only
familiarise the teachers but do not really give the teachers confidence in using them. Alas,
these courses only show the teachers how to follow a cookbook”. The teacher made a valid
point as the training sessions provided by the vendors were, indeed, to familiarize teachers on
the datalogging setup and functions available in the datalogging software, as well as to introduce the set experiments that were included with the datalogging package. There was little or no mention on how to incorporate dataloggers into the curriculum, for example, designing activities that could be used in school-based practical assessment, project work, or inquiry-based science. Full exploitation of datalogging not only requires knowledge of the workings of the sensors and the facilities available in software, but also vision of how the tool or method might be used for scientific enquiry (Rogers & Wild, 1996).

It can be seen from the statistics and the comments that a major factor in datalogger use is the low frequency of using something that is considered complex and which requires care and precision. If the datalogger was conceived as being of a similar complexity as the thermometer, then its use and impact would be considerably greater. Dataloggers, at present, are considered more an innovative piece of equipment like a computer rather than a routine appliance, which is the case in commercial and industrial laboratories. The more frequently teachers use dataloggers, the less ‘fearsome’ and ‘formidable’ the dataloggers become.

**Integrating Dataloggers into the Curriculum.** It came as no surprise that 178 respondents (29.7%) indicated in question DY21 (see Appendix) that the support structure they found most lacking was courses to incorporate dataloggers into the curriculum. In question DY22 (see Appendix), the respondents indicated that they wanted courses to show what concepts or topics could be taught/learned using dataloggers and how to carry out such lessons. Some of the teachers’ comments on datalogging and the curriculum were:

“A demo on specific setup to be used to teach specific objectives.”

“More experiments catering to the A-level syllabuses could be infused into the curriculum.”
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“All the different types of sensors, what topics they can be used for, what concepts can be taught with them.”

“Propose the topics/activities whereby dataloggers are a plus point to integrate into teaching.”

“The way or the topics we can integrate datalogger into curriculum in Biology related topics or a manual with applications in curriculum.”

“More hands on sessions for teachers with resource for teachers containing many experiments worksheets ready for class use.”

“More samples of practical activities that promote integration of dataloggers in lower secondary science topics.”

While the Educational Technology Division, Ministry of Education, Singapore, conducted several courses to help teachers integrate the use of dataloggers in specific curriculum areas (physics, chemistry, biology, lower secondary science and primary science), these workshops and activities were generally one-off, so not many teachers, especially the newer teachers, might not have the opportunity to attend them. Workshop activities included fieldwork at a bird sanctuary and the Mesocyclops project which sought to investigate how the problem of dengue mosquito breeding could be reduced in Singapore. While the teachers were introduced to topics and teaching strategies that would be supportive of appropriate datalogger use, access and pressures to complete a certain number of content topics within a largely inflexible schedule were pulling the teachers in other directions.

Instruction Manual for Using Dataloggers. To have step-by-step instructions or a manual containing datalogging activities was ranked as the third most important support

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1 More details on the project can be obtained at http://www.moe.gov.sg/edumall/etd/meso_web/index.html
Datalogging structure, and 19.5% of the respondents indicated that it was lacking. Other than the manuals provided by the vendors, there appears to be little material on datalogging available to teachers. Thirteen respondents were forthright, with their wish to be supplied with materials to use in class as illustrated by the following comments:

“A separate practical guide book incorporating the use of dataloggers which is in line with the syllabus taught in school.”

“Availability of resources like preparation lists / worksheets for the various levels especially junior college.”

“Practical and simple experiments that are easy to use dataloggers with.”

“Ready made lesson plans should be given to schools for schools to adapt and modify to each individual schools' needs.”

“Ready to use experiments that are closely relevant to the syllabus.”

This desire for instructional material is directly related to the perceived lack of support for integrating dataloggers into the curriculum. From the above comments, while teachers were asking for manuals, it seemed that they were actually asking more for worksheet solutions! This is again a consequence of the pressures to complete the syllabus, and hence the lack of time available to design datalogging activities for use in school and for innovative learning strategies or inquiry strategies.

**Collaboration with Fellow Teachers and Student IT Representatives.** Collaboration with fellow teachers was ranked fourth in importance by the respondents and was considered to be lacking by 17% of the respondents. A small number of respondents (11) would like to have more sharing of best practice and resources amongst teachers, particularly within the same
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school cluster. In Newton’s study (2000), UK teachers also valued collaboration with colleagues, especially those who were enthusiastic about datalogging and were able to lead and support their use of dataloggers. Singapore teachers appreciated the assistance of student IT representatives as they had to manage a class of 40 students and it was difficult to attend to the queries of many students at a time. However, while 21% of teachers thought student IT representatives were not sufficiently available in schools, their presence was not ranked highly – seventh in overall importance.

*Difficulties faced by respondents*

In item 23 (see Appendix), respondents were asked to rank the difficulties that deterred them from using dataloggers. Their responses are given in Table 11.

| Table 11 about here |

Most respondents (407 or 84%) ranked the time spent on setting up datalogging activities as the number one deterrent to the use of dataloggers; it was also by far the highest mean rank. Some of the teachers’ comments included:

- “Shortage of time, needs about three periods. Usually after curriculum time.”
- “Lesson using dataloggers needs too much curriculum time.”
- “More time is required to conduct such a lesson compared with a usual lab lesson.”

In general, it could take about 15 to 30 minutes to set up the dataloggers and apparatus for an activity, and a similar amount of time to dismantle the experimental setup, and account for all
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the apparatus and datalogging equipment. Preparation time could take even longer if calibration of sensors was required. Thus, there was not much instructional time left in a typical laboratory period of 70 minutes to brief students on the activity and for students to complete the activity. However, if the laboratory support staff could set up the activity beforehand so that the students had sufficient time to do the activity, the students might be deprived of the experience of setting up the activity themselves – a less authentic ‘ready-made’ laboratory experience. In addition, the laboratory support staff would need to have the expertise to set up the learning activity, and the laboratory had to free for a sufficient period of time before the teaching session so that the equipment could be set up.

Other logistical constraints which the respondents faced included insufficient computers and the time taken to borrow and return the computers to their point of access. Respondents’ suggestions included:

“A laboratory with sufficient PCs set up properly with software.”

“The availability of PCs or laptops for use during science lessons. These should be in the science lab, where all the other apparatus are.”

“Sufficient (at least 3 student per set) laptops specifically set aside to use in science labs so that lab staff could set them up and students do not have to waste time connecting the various parts.”

“We just need to have enough laptops to be used for group activities. Without enough laptops to go around, it will be very troublesome for teachers to go around to borrow enough equipment for pupils to use.”

“As the school does not have enough laptops, we had to conduct it in the computer labs. This was troublesome as the apparatus had to be brought to a different building.”
While each school was supposed to have sufficient computers for the dataloggers given to them, many seemed to have deployed the computers for other uses. One item on the respondents’ wish list was to have laboratories specifically equipped and set aside for datalogging activities.

“A lab in which the computers are already set up for the use of dataloggers. If not, it takes a lot of time and effort to keep setting up and searching for laptops to use for datalogger lessons.”

“Have a fixed lab for datalogger lessons where. This will minimise the time and hassle in setting up.”

“Due to the limited no. of labs in the school, we do not have the privilege of having all data-logging devices permanently connected in a lab where the pupils can carry out more such experiments in their course of study.”

Mishandling of equipment by students was ranked third in Table 11, “sensors that were insensitive” was ranked fifth, and “software was not user-friendly” was ranked seventh. These relate specifically to the dataloggers. The sensors and interfaces are expensive equipment which may cost a few hundred dollars. They are not very robust and students are not very gentle with equipment. Linn and Hsi (2000) and Murphy (2003) also found that unreliable and fragile sensors were a source of problems in datalogging. Some of the teachers’ commented:

“Good quality dataloggers and well calibrated sensors are important.”

“Some of the sensors are fragile.”

“Faulty sensors/dataloggers with insufficient replacement.”
“Too much time spent on planning experiments that may not work because of the insensitivity of the sensors and user-unfriendly software.”

Equipment failure, physical deployment, access strategies, and technical difficulties are very real problems to teachers using dataloggers (Newton, 2000). Indeed, “technical difficulties and time-consuming troubleshooting remain a reality for teachers – and for many, a significant impediment to using ICT” (Osborne & Hennessy, 2003, p. 32). Without support staff to maintain the equipment and help teachers troubleshoot technical problems, teachers have little incentive to use dataloggers as the perceived pressure on curriculum time carries with it the feeling of wasted instructional time if the topic is not covered within the time allotted.

**Conclusion**

Stories of technologies in education have long suggested that the technologies are not the only focus of concern. This survey has illustrated that with the best intentions, the issues are more around the need for support to design and set up learning activities using dataloggers. Attempts to provide for practical experiences using dataloggers are found daunting by teachers especially those with less support resources and less practical experience in managing such activities. Many respondents did not appear to have appreciated appropriate matches of dataloggers with the appropriate learning activities in science. Through no fault of the teachers, their preparation tended to largely focussed on technical how-to-use-it skills and did not prepare adequately teachers for understanding the role of dataloggers in science inquiry (most teachers had been trained by the individual suppliers and that training was often not fully aligned with the curriculum requirements). The visual and graphical potential for using dataloggers in the analysis and transformation of data and to extend the range of
possible learning activities could never be fully realised in the existing organization structures and contexts for the use of these dataloggers in the schools. However, confident teachers with clear ideas about the use of datalogging in the curriculum, and who are able to organise the classroom, structure the learning tasks, can usefully employ datalogging. The teachers are positive and do try to effectively employ dataloggers as part of their programmes. However, they often find pressures from the organisational structures of the school for the use of these dataloggers and the associated logistical issues such as, sufficient numbers of computers for the class size, reliable software and sensors, easy to understand and use equipment, and trained support technicians are powerful barriers working against the successful implementation of datalogging in schools (Blumenfeld et al., 2000; Rogers & Wild, 1994; Singer, et al., 2000; Somekh, 1997).

References


Murphy, C. (2003) Literature review in primary science and ICT. A Report for NESTA Futurelab (No. 5) (Bristol, NESTA Futurelab).


Appendix: Examples of items in the online survey
(Note in the online version, the open-ended items included space for respondents to type in their comments)

D. Use of Dataloggers
1. Do you use dataloggers in your science lessons/project work/fieldwork/science clubs (in the last 1-2 years)?
   □ Yes □ No

DN1. Have you used dataloggers in the past (more than 2 years ago)?
   □ Yes □ No

DNN1. Do you see any potential in the use of dataloggers for science learning? Describe the potential area(s).

DNY1. When did you last use dataloggers?

DNY2. Why did you stop using dataloggers?

DNY3. Have you thought of using dataloggers in the future? How do you intend to use them?

DY. User
Types of usage
1. Which is/are the subject(s) you used dataloggers with? (You may tick one or more responses)
   Physics/Science(Physics)/LSS(Physics)
   Chemistry/Science(Chemistry)/LSS(Chemistry)
   Biology/Science(Biology)/LSS(Biology)

2. What did you use dataloggers for? (You may tick one or more responses)
   Demonstrations
   Set experiments from workbook/worksheets
   Student initiated investigations
   Fieldwork/Project work
   Enrichment programmes
   Co-curricular activities (e.g. science club, competitions)
   Others (please elaborate)
Support
20. What do you think are important support structures necessary to help you use dataloggers in their science lessons?

Rank the support structures suggested below. (Rank 1 as most important, 2 second in importance and so forth as applicable)

___Laboratory technicians/assistants
___Technical Assistant
___Collaboration with fellow teachers
___Student IT representatives
___Step by step instructions/manuals
___Training on how to use dataloggers
___Courses on incorporating dataloggers into the curriculum
___Others

Please describe the other support structures.

21. Which of the following support structure(s) do you find lacking, e.g. in your school or in courses offered? (You may tick one or more responses)

   Laboratory technicians/assistants
   TA
   Collaboration with fellow teachers
   Student IT representatives
   Step by step instructions/manuals
   Training on how to use dataloggers
   Courses on incorporating dataloggers into the curriculum
   Others (please elaborate)

22. Describe the type of training (if any) you would like to help you integrate the use of dataloggers in your science lessons.

Difficulties faced
23. What were the difficulties that deter you from using dataloggers in your science lessons?

Rank the difficulties suggested below. (Rank 1 as the worst deterrent, 2 as the next worst and so forth as applicable)

___Mishandling of equipment by students
___Sensors were insensitive
___Too much time spent on setting up e.g. calibration etc
___Loaning and returning the dataloggers take too much time
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_____ Graphs/results obtained were different from theory
_____ Unsure how to analyse the graphs obtained
_____ Inability to explain graphs to pupils
_____ Software was not user-friendly
_____ Pupils were unable to interpret graphs
_____ Insufficient laptops or computers
_____ Others

Please describe these other difficulties
Table 1. Distribution of respondents over the types of schools

<table>
<thead>
<tr>
<th>Types of school</th>
<th>Sample</th>
<th>Targeted</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior colleges</td>
<td>68</td>
<td>102</td>
<td>66.7</td>
</tr>
<tr>
<td>Independent Secondary</td>
<td>30</td>
<td>48</td>
<td>62.5</td>
</tr>
<tr>
<td>Autonomous Secondary</td>
<td>78</td>
<td>144</td>
<td>54.2</td>
</tr>
<tr>
<td>Other Secondary</td>
<td>413</td>
<td>756</td>
<td>54.6</td>
</tr>
<tr>
<td>Missing data</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>593</td>
<td>1050</td>
<td>56.5</td>
</tr>
</tbody>
</table>
Table 2. Designation of the respondents

<table>
<thead>
<tr>
<th>Designation</th>
<th>Sample</th>
<th>Targeted</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOD</td>
<td>114</td>
<td>175</td>
<td>65.1</td>
</tr>
<tr>
<td>Teacher</td>
<td>479</td>
<td>875</td>
<td>54.7</td>
</tr>
<tr>
<td>Total</td>
<td>593</td>
<td>1050</td>
<td>56.5</td>
</tr>
</tbody>
</table>
### Table 3. Subjects taught by respondents

<table>
<thead>
<tr>
<th>Subjects taught</th>
<th>HOD</th>
<th>Teacher</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>20</td>
<td>82</td>
<td>102</td>
</tr>
<tr>
<td>Chemistry</td>
<td>64</td>
<td>153</td>
<td>217</td>
</tr>
<tr>
<td>Physics</td>
<td>40</td>
<td>203</td>
<td>243</td>
</tr>
<tr>
<td>Lower Secondary Science</td>
<td>20</td>
<td>218</td>
<td>238</td>
</tr>
<tr>
<td>Missing data</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: A respondent can teach more than one subject.
## Table 4. Distribution of various types of users over the types of schools

<table>
<thead>
<tr>
<th>Types of school</th>
<th>Users</th>
<th>Past users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior colleges (n=68)</td>
<td>52 (76.5)</td>
<td>10 (14.7)</td>
<td>6 (8.8)</td>
</tr>
<tr>
<td>Independent Secondary (n=30)</td>
<td>27 (90.0)</td>
<td>1 (3.3)</td>
<td>2 (6.7)</td>
</tr>
<tr>
<td>Autonomous Secondary (n=78)</td>
<td>59 (75.6)</td>
<td>11 (14.1)</td>
<td>8 (10.3)</td>
</tr>
<tr>
<td>Other Secondary (n=413)</td>
<td>253 (61.3)</td>
<td>69 (16.7)</td>
<td>91 (22.0)</td>
</tr>
<tr>
<td>Missing data</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>All respondents</td>
<td>394 (66.4)</td>
<td>91 (15.3)</td>
<td>108 (18.2)</td>
</tr>
</tbody>
</table>

(Percentages in brackets)
Table 5. Designations of various types of users

<table>
<thead>
<tr>
<th>Designations</th>
<th>Users</th>
<th>Past users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOD (n=114)</td>
<td>79 (69.3)</td>
<td>18 (15.8)</td>
<td>17 (14.9)</td>
</tr>
<tr>
<td>Teacher (n=479)</td>
<td>315 (65.8)</td>
<td>73 (15.2)</td>
<td>91 (19.0)</td>
</tr>
<tr>
<td>All respondents</td>
<td>394 (66.4)</td>
<td>91 (15.3)</td>
<td>108 (18.2)</td>
</tr>
</tbody>
</table>

(Percentages in brackets)
Table 6. Distribution of various types of users over years of teaching

<table>
<thead>
<tr>
<th>Years of teaching</th>
<th>Users</th>
<th>Past users</th>
<th>Non-users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 (n=214)</td>
<td>123 (57.5)</td>
<td>37 (17.3)</td>
<td>54 (25.2)</td>
</tr>
<tr>
<td>5 to 10 (n=140)</td>
<td>97 (69.3)</td>
<td>23 (16.4)</td>
<td>20 (14.3)</td>
</tr>
<tr>
<td>11 to 15 (n=59)</td>
<td>39 (66.1)</td>
<td>12 (20.3)</td>
<td>8 (13.6)</td>
</tr>
<tr>
<td>16 to 20 (n=61)</td>
<td>46 (75.4)</td>
<td>8 (13.1)</td>
<td>7 (11.5)</td>
</tr>
<tr>
<td>Greater than 20 (n=115)</td>
<td>87 (75.7)</td>
<td>11 (9.6)</td>
<td>17 (14.8)</td>
</tr>
<tr>
<td>All respondents (n=593)</td>
<td>394 (66.4)</td>
<td>91 (15.3)</td>
<td>108 (18.2)</td>
</tr>
</tbody>
</table>

(Percentages in brackets)
Table 7. Reasons why past users stopped using dataloggers (n=91)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of time</td>
<td>43</td>
<td>47.3</td>
</tr>
<tr>
<td>Equipment-related issues</td>
<td>32</td>
<td>35.1</td>
</tr>
<tr>
<td>Difficulty in incorporating datalogging into the curriculum</td>
<td>15</td>
<td>16.5</td>
</tr>
<tr>
<td>Facilities-related issues</td>
<td>4</td>
<td>4.4</td>
</tr>
<tr>
<td>Lack of staff support</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Others/no necessity</td>
<td>8</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Note. A respondent might give one or more reasons, so the total number of reasons is greater than 91.
Table 8. Uses of dataloggers

<table>
<thead>
<tr>
<th></th>
<th>Demo</th>
<th>Experiment</th>
<th>Field/ Project</th>
<th>Enrichment</th>
<th>CCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>User (n=394)</td>
<td>237 (60.2)</td>
<td>241 (61.2)</td>
<td>75 (19.0)</td>
<td>78 (19.8)</td>
<td>24 (6.1)</td>
</tr>
<tr>
<td>Past user (n=91)</td>
<td>51 (56.0)</td>
<td>32 (35.2)</td>
<td>17 (18.7)</td>
<td>17 (18.7)</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>All users (n=485)</td>
<td>288 (59.4)</td>
<td>273 (56.3)</td>
<td>92 (19.0)</td>
<td>95 (19.6)</td>
<td>27 (5.6)</td>
</tr>
</tbody>
</table>

(Percentages in brackets)

Note. A respondent might indicate more than one area, so the total number of users is greater than 485.
Table 9. Ranking of support structures by respondents

<table>
<thead>
<tr>
<th>Support structures</th>
<th>Mean rank</th>
<th>Number of respondents (n=485)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory technicians/assistants</td>
<td>2.65</td>
<td>446</td>
</tr>
<tr>
<td>Training on how to use dataloggers</td>
<td>3.17</td>
<td>417</td>
</tr>
<tr>
<td>Step by step instructions/manuals</td>
<td>3.29</td>
<td>431</td>
</tr>
<tr>
<td>Collaboration with fellow teachers</td>
<td>3.52</td>
<td>435</td>
</tr>
<tr>
<td>Courses on incorporating dataloggers into the curriculum</td>
<td>3.89</td>
<td>339</td>
</tr>
<tr>
<td>Technical assistants</td>
<td>4.29</td>
<td>383</td>
</tr>
<tr>
<td>Student IT representatives</td>
<td>5.38</td>
<td>378</td>
</tr>
</tbody>
</table>
Table 10. Support structures which were lacking in school or in courses offered

<table>
<thead>
<tr>
<th>Support structures which are lacking</th>
<th>Number of respondents (n=485)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses on incorporating dataloggers into the curriculum</td>
<td>178</td>
<td>29.7</td>
</tr>
<tr>
<td>Student IT representatives</td>
<td>126</td>
<td>21.0</td>
</tr>
<tr>
<td>Step by step instructions/manuals</td>
<td>117</td>
<td>19.5</td>
</tr>
<tr>
<td>Laboratory technicians/assistants</td>
<td>106</td>
<td>17.7</td>
</tr>
<tr>
<td>Collaboration with fellow teachers</td>
<td>100</td>
<td>16.7</td>
</tr>
<tr>
<td>Technical assistants</td>
<td>93</td>
<td>15.5</td>
</tr>
<tr>
<td>Training on how to use dataloggers</td>
<td>84</td>
<td>14.0</td>
</tr>
</tbody>
</table>
Table 11. Difficulties which deter the respondents from using dataloggers

<table>
<thead>
<tr>
<th>Difficulties</th>
<th>Mean rank</th>
<th>Number of respondents (n=485)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much time spent on setting up, calibration etc</td>
<td>2.30</td>
<td>407</td>
</tr>
<tr>
<td>Insufficient laptops or computers</td>
<td>3.95</td>
<td>374</td>
</tr>
<tr>
<td>Mishandling of equipment by students</td>
<td>4.05</td>
<td>356</td>
</tr>
<tr>
<td>Lending and returning the dataloggers takes too much time</td>
<td>4.38</td>
<td>315</td>
</tr>
<tr>
<td>Sensors were insensitive</td>
<td>4.44</td>
<td>330</td>
</tr>
<tr>
<td>Graphs/results obtained were different from theory</td>
<td>4.73</td>
<td>311</td>
</tr>
<tr>
<td>Software was not user-friendly</td>
<td>4.78</td>
<td>330</td>
</tr>
<tr>
<td>Unsure how to analyse the graphs obtained</td>
<td>6.02</td>
<td>284</td>
</tr>
<tr>
<td>Pupils were unable to interpret graphs</td>
<td>6.19</td>
<td>293</td>
</tr>
<tr>
<td>Inability to explain graphs to pupils</td>
<td>7.20</td>
<td>271</td>
</tr>
</tbody>
</table>