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Coordinating diverse research practices using Digital Research Notebooks - a case study in Science Education

João Fernandes

João Fernandes is researcher in Science Education in New University of Lisbon, with interests in learning spaces, active learning, activity theory, open educational resources and ICT in education; He is also a teacher trainer on ICT in education, particularly in an online school for traveller children. He is co-founder of the research cooperative Cultivare – Cooperation, Action, Ethics CRL, based in Portugal and of OneNote in Research, offering training in OneNote for researchers and design of Digital Research Notebooks.

New University of Lisbon, Portugal

Luis Barbeiro

Luis is an independent researcher and developer of digital tools for research and co-founder of OneNote in Research - training in OneNote for Researchers and design of Digital Research Notebooks. He has over 20 year of experience as a teacher, trainer and researcher of Science Education in formal and informal environments. He is interested in participatory practices, science and society interactions and open research. He was also a co-founder of the research cooperative Cultivare – Cooperation, Action, Ethics CRL.

London, UK

Relevant disciplines

Education, Science Education, Research Methods

Academic levels

Undergraduate and post-graduate

Methods used

Research Design, Collaborative research, Mixed method research, Literature review, Participant Observation, Survey designs, Interviews, Mobile methodologies, Computer-assisted qualitative data analysis (CAQDAS), E-research

Keywords

Digital Research Notebooks, Digital tools, Collaboration, Project Management, Mixed methods, Mobile Data Capturing, OneNote, CAQDAS, QDAS

Link to the research output

<http://laboratorioscolares.net/ptdc-mhc-ced-5116-2012>

<http://onenoteinresearch.com/>

Abstract

This case study provides an account on how we struggled with the coordination of the many activities of a research project in Science Education. Managing the project as a whole and working collaboratively on the literature review, the integration of diverse research methods (interviews,

classroom observation, survey), analysis and reporting turned out to be a productive challenge. The initial difficulties led us to develop the concept of Digital Research Notebook, a meta-tool and workflow to coordinate many of these activities. We will give practical examples of how we developed some of the project's research activities before and after we began using the Digital Research Notebook. We will focus on: Collaboration (e.g. writing a paper collaboratively); Project management (e.g. task management); Literature review (e.g. annotating publications collaboratively), Interviews (e.g. collecting audio and handwritten notes in an integrated way), Classroom observation (e.g. a workflow to produce pedagogical graphic novels) and a Survey (e.g. making the dataset and design process open). Our aim is also to present you with scenarios through which you can reflect on the relevance of Digital Research Notebooks and envision its adaptation to your own research project.

Learning outcomes

By the end of this case, you should:

1. Understand the practical problems arising from the diversity of activities in a research process;
2. Develop strategies for collaboration in research and project management through Digital Research Notebooks;
3. Explore ways to coordinate disparate data and analysis using a Digital Research Notebook;
4. Reflect on the possibilities of Digital Research Notebooks for your own research project;

Research project overview

This case study, which will illustrate the applications of Digital Research Notebooks (DRN), will take as background a research project which aimed to identify the attitudes and expectations

attributed by teachers to a new school science space model, the Science Learning Studio (SLS), analyse teaching and learning activities and inquire about the current situation of instructional, practical and project-based activities in these new spaces.

The current plan by Parque Escolar, a public company responsible for the modernisation of the Portuguese secondary schools' buildings, established a new school building model prioritising the schools' science spaces, modelled on the SLS. Since 2007 this model has already been implemented in 115 schools across the country.

Unlike the Anglo-American model of science learning spaces, formalised in a single laboratory for all classes with daily activities of observation and / or experimentation, the Portuguese previous model included both traditional classrooms for lectures and laboratories for practical work.

This bipartite model contrasts with the new model, in line with the learning studios and classrooms / environments for active learning in scientific subjects (see for example Robert Beichner's Scale-UP project to get an idea <http://scaleup.ncsu.edu/>), a hybrid space to support instruction, practical work, peer-instruction and diverse teaching and learning activities.

The drive to develop the concept of Digital Research Notebooks

For this research project, we designed a path of mixed methods to approach the research questions, which began with case studies involving classroom observation, interviews and later a survey to teachers using these new spaces. It became evident early on in the research process that trying to connect such diverse capture methods and data analysis would be a complex task. Our everyday problems went beyond this methods issue, as we lacked adequate project management and collaboration tools to coordinate the project as a whole.

We looked into the literature that could help us map all the activities of our research process and start to address these challenges in a more structured and consistent way. From Miles & Huberman we understood that a qualitative research process may involve:

- a. collaborating
- b. reviewing the literature
- c. generating data
- d. storing, protecting and managing data
- e. searching
- f. transcribing
- g. memoing
- h. editing
- i. coding
- j. data linking
- k. analysing content
- l. data displaying
- m. graphic mapping
- n. writing
- o. research project managing

One possible way forward would be to use a QDAS (Qualitative Data Analysis Software) package. Despite the focus on data analysis, these highly advanced software are evolving to provide support to many of the above activities. We began using one of these packages but the learning curve was high for some team members, the costs were significant and there was a need for easier integration of the software to accommodate the diversity of individual working processes and tools. Project management and collaboration were also not being coordinated in an easy way so our work became muddled.

Table 1 - Research activities and digital tools used before developing the Digital Research Notebooks

Research activity	Tools
Collaborating	Google Drive and Skype
Reviewing the literature, generating data and memoing	Adobe Acrobat Professional, Evernote, Microsoft OneNote and Mektosj Papers
Storing, protecting and managing data	Dropbox, Bittorrent Sync and Synctoy
Transcribing, analysing, coding and data linking	NVivo
Data linking and graphic mapping	VUE, Mural, NVivo
Writing	Adobe InDesign, Google Drive, Microsoft Word
Project managing	Folders, Google Tasks, Trello, Google Calendar

With this in mind, we began developing the concept of DRN, not as a way of eliminating this diversity of tools and processes, but to provide a common ground that supported our research activities as a whole.

What are Digital Research Notebooks after all?

We engaged in a search for platforms that could provide the coordination we were lacking. We tried several project management and collaborative platforms, collaborative design and

innovation platforms, mostly business oriented, but remained unsatisfied. We ended up resorting to a tool that we had already been using for several research projects in a simpler way – Microsoft OneNote.

OneNote is usually portrayed as a digital notebook for general audiences. It has meanwhile encountered several applications in education, but not in mixed methods research, as far as we know. We had used OneNote for research notetaking, memoing and literature reviewing for more than 8 years. Facing difficulties in coordinating our research practices and supported by the research literature on software for qualitative research (e.g., the work of Paulus, Lester, Dempster, Silver & Lewins), we developed procedures and templates which made OneNote an useful digital tool for our entire research process. We named these notebooks tailored to our research DRN.

In the following sections we will describe several practical issues that arose in a Science Education research project and on how DRN helped us deal with the myriad of activities involved in the entire research process:

1. Collaboration (e.g. writing a paper collaboratively)
2. Project management (e.g. task management)
3. Literature review (e.g. annotating publications collaboratively)
4. Field work and data analysis
 - a. Interviews (e.g. collecting audio and handwritten notes in an integrated way)
 - b. Classroom observation (e.g. a workflow to produce pedagogical graphic novels)
 - c. Survey (e.g. making the data set and design process open)

Collaboration

We will describe and analyse an example of collaboration in our research project, writing a paper collaboratively, by focusing on its practical features. We will try to illustrate a scenario

of how we did some of the collaborative writing in previous projects, the challenges that arose and how we developed the DRN to find better ways of working in the current project.

Exploring creativity – connecting different sources

In the process of writing a paper, we would begin by discussing ideas, mentioning some articles, etc. and jotting down some notes about it. We would then write a provisional index of topics and sort which parts each person would write. This was usually done in a meeting and the draft index would be emailed to the group.

Using the DRN allowed us to better explore these first stages of writing. For a creative brainstorming we developed a Canvas template with the possibility to write anywhere, very similar to what can be done with post-its on a wall.

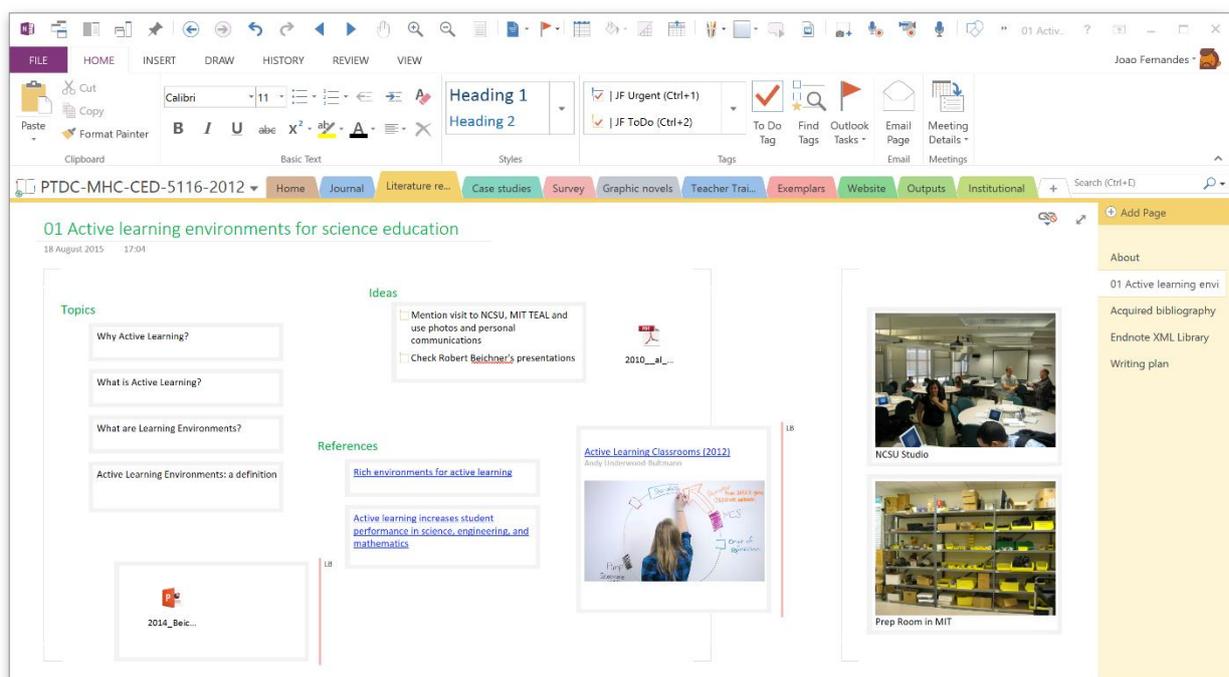


Fig. 1 - A collaborative open canvas for writing a paper, from the initial brainstorming to the definition of a provisional index.

This made a considerable difference in sparking creativity. It was more versatile than just playing with post-its, because it allowed us to place text, photos, screen clips, videos, drawings

and files all in the same place. We could also move these elements in the Canvas, connect them, sort them, etc. and thus explore our ideas more grounded in data. From an initial chaotic display of things, we ended up with an organised collage of data. This made it easier to do a provisional index for writing and have available information we could readily use to develop the paper. There was no need to email the provisional index as it was done in a notebook page shared between the authors.

Grounded writing - keeping your sources close

Before using DRN, on receiving the draft index by email we would then work individually in a word processor of choice and using our own personal way of writing. We would add pieces of previous texts, write and rewrite new text, add citations, notes on sources, comments, etc. We tried to keep a close connection between what we were writing and the sources of information that inspired that piece of text or worked as evidence. We would usually make a note to direct us to it. This would be in the form of a link to a file or source but this was very cumbersome to make and follow.

Writing in the DRN solved the problem of relating the writing with the actual sources, making it more grounded. Besides writing, in the DRN pages we could insert any type of file (PDF, Word, Excel, PowerPoint, photos, audio, video, etc.). This meant that at the end of any paragraph we could have the actual source, or a link to it in another notebook page.

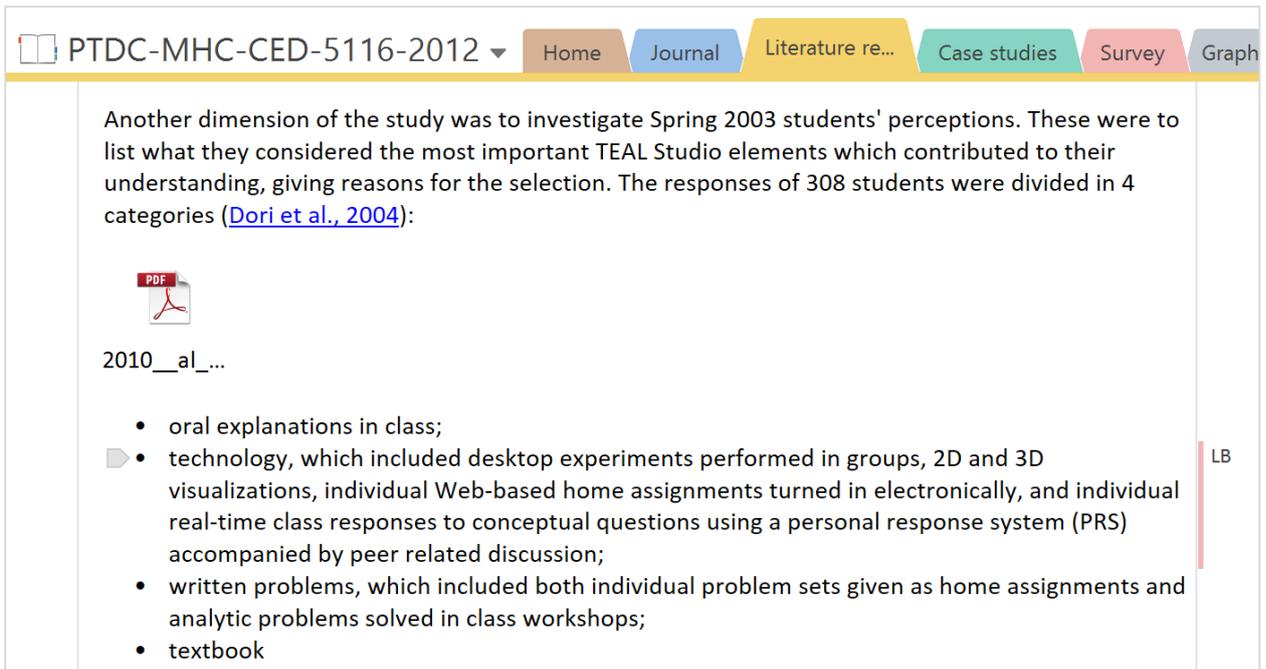


Fig. 2 - An example of writing in a grounded way, keeping sources (PDF, PWP, DOC, etc.) accessible across the text.

This linking ability between text and files extended also to text paragraphs. With a few clicks we could make a link from one paragraph to another.

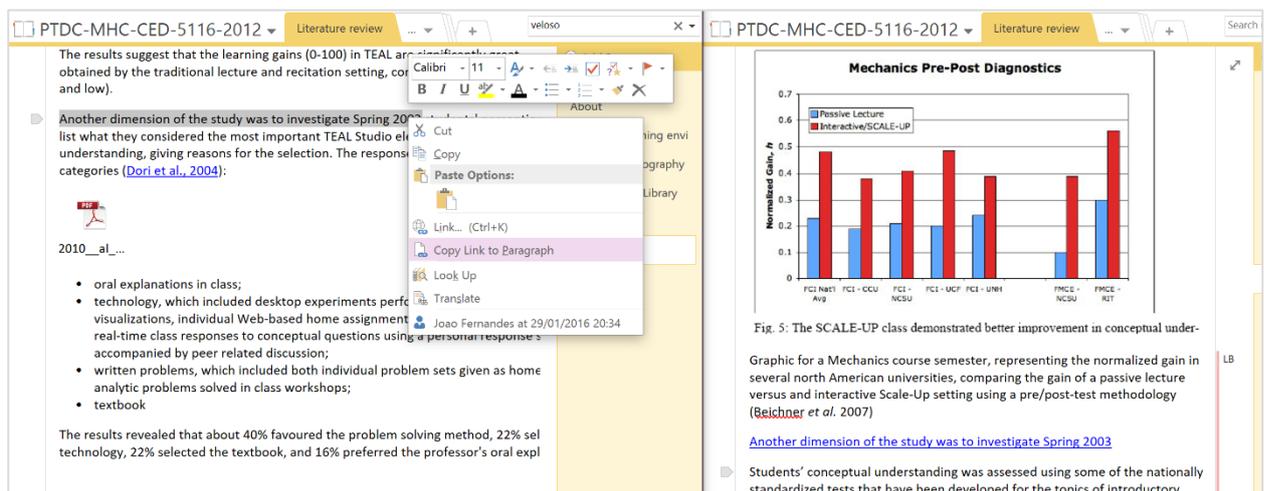


Fig. 3 - Linking paragraphs of text can improve depth of analysis, by selecting "Copy link to paragraph" in the destination text and pasting it within another text.

We now had the ability to better grasp, compare and analyse different pieces of texts and make our writing more creative and grounded.

Bridging the gap between writing individually and collectively

Before using DRN, when the individual writing of each topic had evolved and was clear enough, we would put our writings together in a single common file (usually in Word) and share it between authors.

We would then read each other's work and use the review features (comments, track changes and versions) to make suggestions, corrections, etc. The file would be sent back and forth by email and if this became too frequent, we would place the file in a shared cloud drive (Dropbox, Google drive). We would then email each other or use a chat (Skype) just to report the status of the document, or to request comments or follow-up.

When we were together we could write on the same piece of text while discussing it. In an online meeting this would be done using the sharing screen feature. Sometimes, when we really needed to advance the text faster, we would use Google Docs to edit the text at the same time.

With the DRN our work became collaborative from the start. Instead of working individually in separate Word files, each of us worked in different pages in the same notebook section. The pages in the DRN are organized similarly to a pen and paper notebook. In the notebook section dedicated to the paper, we would have a page for each topic (and sub-pages, if needed). Each page would initially be attributed to an author and later reviewed by everyone.

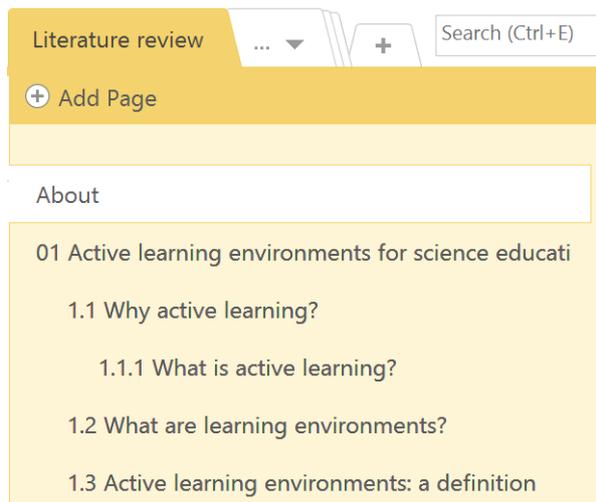


Fig. 4 - In a way similar to a paper notebook, the DRN is organised into sections, with pages and subpages.

Having all the writing in the same place and everyone with easy access to it made a difference in the way we communicated and wrote. The ability to quickly skim through each other's texts also let us have a bird's eye view of its progress.

When we needed to write collectively in a single page, OneNote had a set of unique features that helped our collaborative writing:

1. Turning to bold the title of every page recently edited by other authors;
2. Highlighting all new edits in a page with a green background;
3. Identifying the last author of each paragraph of text, through a coloured ribbon on its right side;
4. Searching for recent edits, by author, in a certain page or section;
5. Using visual tags (like To Do) in paragraphs to comment, ask questions, etc.

PTDC-MHC-CED-5116-2012 ▾ Home Journal Literature review Case studies Survey Graphic novels T

The findings of comparison studies between Scale-Up and Lecture/Laboratory classes are summarized below (Beichner *et al.*, 2007, p.37):

- “Conceptual understanding is increased;
- The top third of the class show the greatest improvement in conceptual misunderstanding; LB
- Ability to solve problems is as good or better;
- Attitudes are improved;
- Class attendance is higher, typically > 80%; LB
- Failure rates are drastically reduced (typically 50%), especially for men and minorities;
- Performance in the second semester physics class is improved, whether taught traditionally or in SCALE-UP;
- Failure of at-risk students in a later Engineering Statics class is cut in half.”

Check paper Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415.
<http://doi.org/10.1073/pnas.1319030111>

Fig. 5 - OneNote has multiple collaborative features, such as showing the initials of the last author of each paragraph on its right side, highlighting the background in green for unread edits, etc.

All this would let us know about recent edits, which part of the text was written by whom, easily follow-up changes or comment directly with the author.

We would work on the text in the DRN until it was ready for final editing. For this final stage we would export the notebook pages to Word to apply formatting, count words, number pages, insert references, etc. When working on the final version of the Word file, we would place it in OneDrive to work synchronously and online on it. We would also insert it in a notebook page, to have easy access to it and to archive it.

Project and data management

In our previous research activities, project management was usually done informally, without much consideration or effort put into it. We were confronted with a series of difficulties while trying to manage the project collectively and as a whole. Through the DRN we tried to find solutions to task and time management, logging, auditing, analytical and institutional data management.

Task management

In meetings, we would decide on the next steps and attribute tasks to each colleague. We would then jot down a few points or make a list. The list would later be shared by email with everyone. Sometimes more detailed lists would be done individually by the person in charge of the task to better organise it and control its development.

If the project tasks demanded deeper collaboration we would write To Do lists in a shared Evernote notebook. Though useful, this would usually become an "infinite" list full of left over To Do's.

The DRN opened up the possibility for a finer grain management of the project.

The way we defined tasks became clearer and better grounded on the actual work we were doing. In the DRN tasks could be written as a To Do in the actual page or piece of text where they originated. We did not have to move to a task page or To Do list page to write them down, losing focus and also separating the context from the task.

The screenshot shows a digital workspace interface. At the top, there is a navigation bar with tabs for 'Home', 'Journal', 'Literature review', 'Case studies', 'Survey', 'Graphic novels', and 'Te'. The main content area displays a document titled 'PTDC-MHC-CED-5116-2012'. The document text describes tangible activities related to physical situations, such as determining the thickness of a sheet of paper or calculating the spacing of frets on a guitar. Below the text, there are several interactive elements: a comment box asking 'How can this support the taxonomy of activities, from aesthetic to meta-cognitive?', a response 'Not sure it can!' with a 'LB' label, a task box 'Integrate Fermi, Back of the Envelope and Concept tests', and another comment box asking 'They are asked why they need to do this (and references are made to Newton's Second Law.)' with a 'LB' label. A final comment box contains a detailed orange-colored response: 'Once they state that they are applying a force to the ball to change the direction of its motion, they are asked to specify the direction of the force. Socratic dialoguing eventually results in the recognition that the force is always directed toward the centre of the concentric arcs. They quickly recognize this as a centripetal force and then have to approximate its magnitude from the mass of the ball and an estimate of its speed' (Beichner et al., 2007, p.13).

Fig. 6 - Tasks can be identified with check boxed tags and applied in context. Tags can be customised with icons for different types of tasks (To Do, To Think, Comment, Important...)

Besides the To Do checklist tag, we developed a simple collection of visual tags that let us leave notes to oneself and others and to manage our activities. We called them processual tags, as they facilitated the moving forward of the research processes: to-do, to-think, important, comment, common, etc. This tagging was also made in context. Following up tasks became simple as the DRN was able to collate all the tags, through a "Find tags" feature. This gave us a bird's eye view of what was significant and had to be acted upon. We could even generate summary reports of the tags, by author, type or date, facilitating how we managed our tasks.

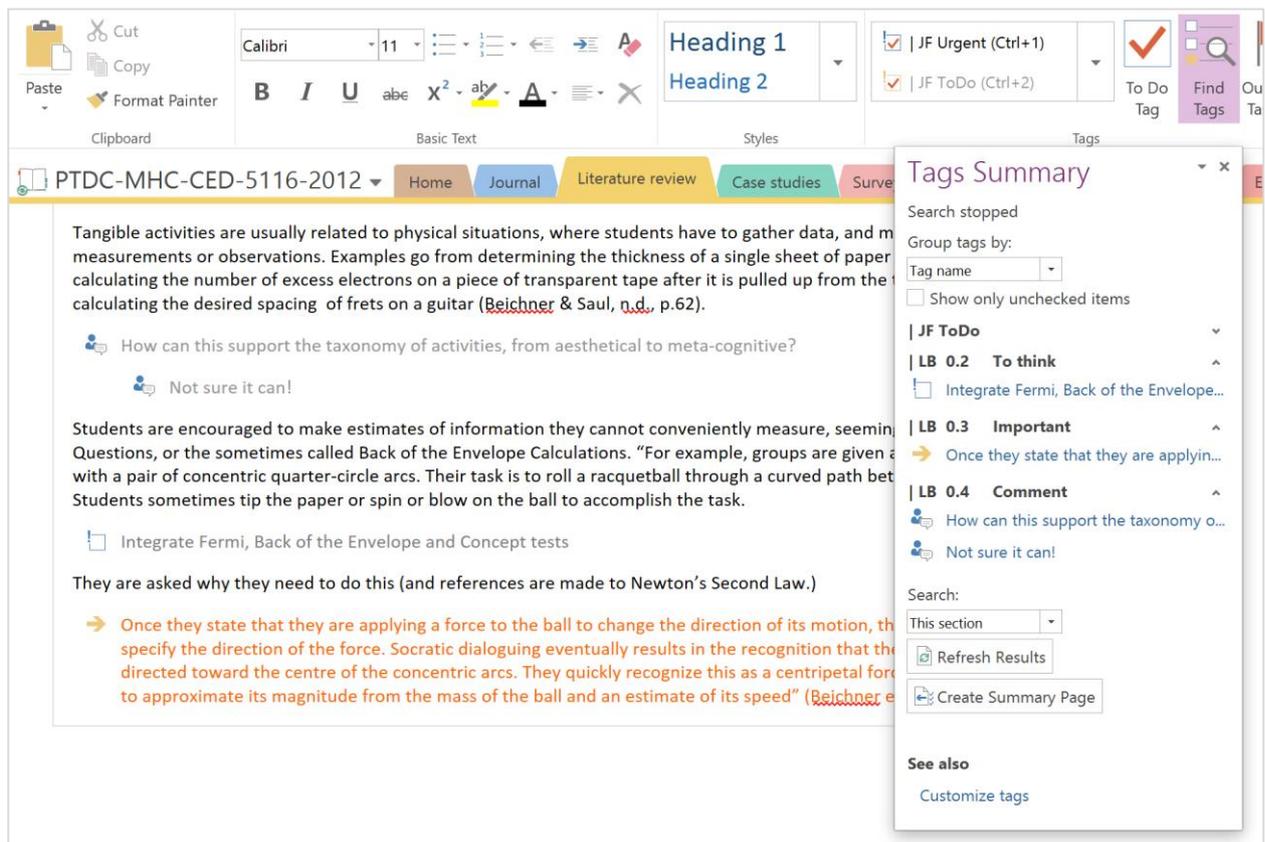


Fig. 7 - Tasks can be searchable by page, section or notebook, by author or time. Tag summaries provide a quick report of tasks.

Time management

For time management purposes, such as organising meetings, defining deadlines or scheduling field work, we started using a shared Google Calendar or Doodle.

With the DRN we could add a time tag to any task, like today, tomorrow or specific to a date and time. Timed tasks were automatically integrated with Outlook tasks, and could be viewed in the application. We could then add reminders to these tasks to get for example alerts on our mobile phones.

Logging and auditing

For the team to be able to follow what was happening in the project, we tried to integrate the tasks with the calendar (Outlook or Gmail) to generate a kind of log of all activities. This was something that was never easy to achieve and the detailing of so many small tasks did not help.

To solve this, in the DRN we decided to develop a Logger, a calendar-like section, where we collectively added the main themes being worked on that week, with direct links to the section or pages in progress.

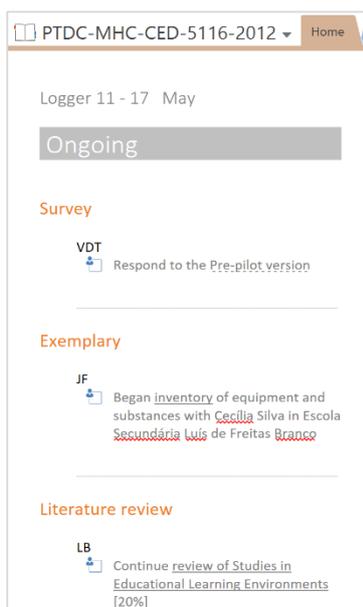


Fig. 8 - The Logger provides a bird's eye view of the ongoing project. It can help every member of the team to follow the main topics being worked upon.

We also thought of maintaining a collective Research journal where we would periodically collect the significant moments of the research: data, insights, reflections, events etc. To have reflective purposes, the journal could be multimedia and had links to the sources of information elsewhere in the notebook. Any participant could edit or comment it. We developed a Graphic Novel template to collect information from other parts of the notebook to make this journal easy to follow. This format was useful in showing other stakeholders how the research process was going.

These two features, the Logger and the Research journal, linked to the content of research, made our research process more open and our work more auditable and ethical.



13 - 19 January 2014

20 de janeiro de 2014 16:04

Interesting article and a video of teaching and learning in active learning environments

[The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis](#)

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2013). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 69(1), 118-135. <http://dx.doi.org/10.1016/j.buildenv.2013.07.010>

[The impact of classroom design on pupils' learning: Final results](#)

[Teaching and Learning Experiences in Active Learning Classrooms: Highlights](#)

McGill University

1 interesting article, in open access. We are reviewing this paper.

We were also looking for how students experience active learning environments and found an interesting video.

SCALE-UP

Student-Centered Active Learning Environment with Upside-down Pedagogies

How would you like to teach (or learn) in a classroom for the first time in 2017?

[SCALE-UP](#)

A reference website from NCSU maintained by Robert Beichner with several videos about active learning environments.

[TILE: Transforming the Classroom Experience](#)

uimediamproduction

Mary Adamek
School of Music faculty

Fig. 9 - The Collective Research Journal shows the relevant moments of research in a multimedia graphic novel style, for reflective purposes and for keeping stakeholders informed.

Data management

Before developing the DRN, we captured the many data files (interviews, classroom observations, etc.) with cameras, audio recorders and handwritten field notes on paper. Photos, audio and video files were then stored locally and organised into folders. To share these local files we used cloud services (Dropbox for non-sensitive documents and Bit torrent Sync for

through the ability of Outlook to send emails directly to OneNote. This made possible the creation of a repository of relevant email.

All the information, now in one place, could be easily shared and collectively organised, facilitating search and linking, fostering analysis at a deeper level. General information was closer to the data and analysis, making the management of the project as a whole easier when we needed to write reports, ethical approvals, etc.



Fig. 11 - The Institutional section integrates general information related to the research project, such as emails, grant application documents, acceptance terms, regulations, accounting, etc.

Literature review

The literature we were interested for this project was quite diverse. Some was acquired in paper or digital, other was available in online repositories or came from personal collections. We made the effort of scanning some of the publications with OCR (Acrobat Professional XI) and defining a common format for our digital library (PDF), later organised in a reference

management software (Papers). We could make full content searches of all the publications and comment and annotate them.

Creating a Library section in a Digital Research Notebook

We started developing Library sections in our DRN for specific themes. The sections were organised by themes and in Publication Collector' pages. We added the PDF file of the publication to each page, along with some metadata and a summary review. The files in the notebook could still be shared with the reference management software if they were imported from a common cloud drive (like OneDrive or Dropbox), keeping the access to the latest version of the file.



The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis

18 August 2015 16:23

The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis



The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis

Peter Barrett¹, Fay Davies¹, Yufan Zhang¹, Lucia Barrett²

ABSTRACT
Assessments have been made of 153 classrooms in 27 schools in order to identify the impact of the physical classroom features on the academic progress of the 3766 pupils who occupied each of those specific spaces. This study confirms the utility of the naturalness, individuality and stimulation (or more memorably, SIN) conceptual model as a vehicle to organise and study the full range of sensory impacts experienced by an individual occupying a given space. In this particular case the naturalness design principle accounts for around 50% of the impact on learning, with the other two accounting for roughly a quarter each. Within this structure, seven key design parameters have been identified that together explain 16% of the variation in pupils' academic progress achieved. These are Light, Temperature, Air Quality, Ownership, Flexibility, Complexity and Colour...

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89(C), 118–133.

<http://doi.org/10.1016/j.buildenv.2015.02.013>

date: 25/08/2015
place: Digital Tools for Qualitative Research from SAGE
captured by: LB

other:

reading memo

abstract

Assessments have been made of 153 classrooms in 27 schools in order to identify the impact of the physical classroom features on the academic progress of the 3766 pupils who occupied each of those specific spaces.

This study confirms the utility of the naturalness, individuality and stimulation (or more memorably, SIN) conceptual model as a vehicle to organise and study the full range of sensory impacts experienced by an individual occupying a given space. In this particular case the naturalness design principle accounts for around 50% of the impact on learning, with the other two accounting for roughly a quarter each.

Within this structure, seven key design parameters have been identified that together explain 16% of the variation in pupils' academic progress achieved. These are Light, Temperature, Air Quality, Ownership, Flexibility, Complexity and Colour...



The impact of classroo...

Fig. 12 - In the Library section of a DRN, there are several Publication Collectors. In this template, we can add a cover, a PDF, some metadata and a summary of a publication for future reference.

Annotating publications collaboratively in one place

Most reference managers allow annotations in PDF, but relating texts excerpts within and between papers or moving your annotations for further editing is more demanding. This turns analysis into a cumbersome process. If you add collaboration to this, the problem grows exponentially.

This led us to develop a workflow to make collaborative annotations, linking and tagging/coding that made possible a more in-depth analysis of the literature.

With the PDF opened from its Publication Collector, we would place it side by side with a Literature Review Matrix template – a series of columns with card like cells - and then copy excerpts from the PDF and paste them in the cards. In PDF protected from copy/paste we would use the OneNote screen clipping tool and cut and paste the screen region of the paragraph we were interested in collecting, and then apply the feature of text recognition in images.

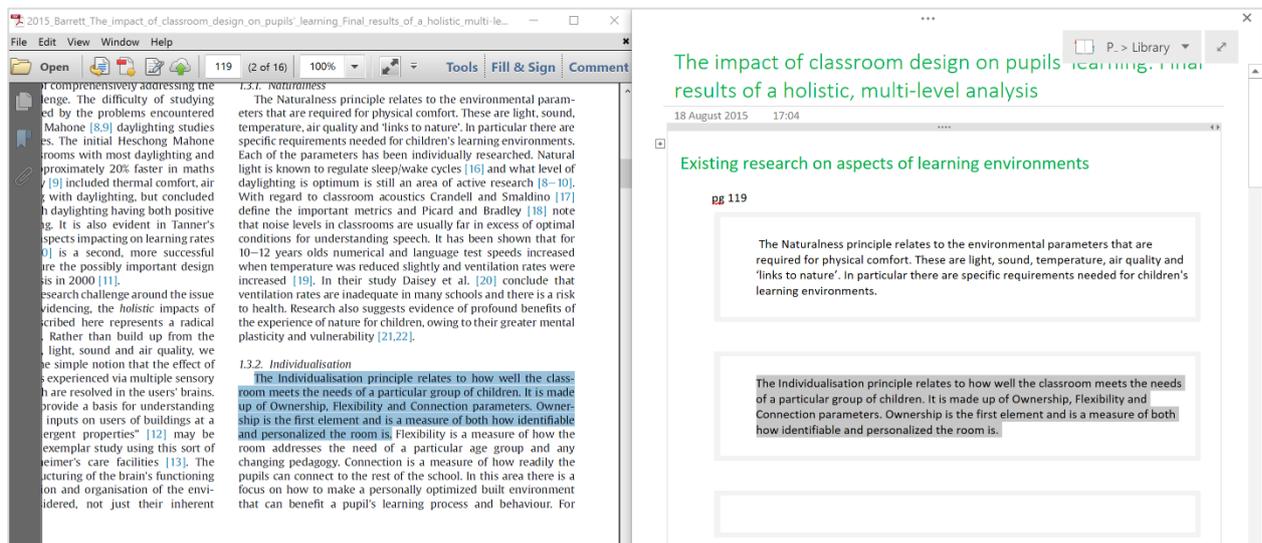


Fig. 13 - To analyse a text, excerpts from PDF can be copied and pasted in a Literature Review Matrix template – a series of columns with card like cells.

What OneNote offered, more than extracting text from publications in an organised way, was a set of text manipulation tools (highlighting, outlining, drawing upon) and most of all, the ability to link and tag paragraphs.

Linking and tagging paragraphs

Linking paragraphs of text within the same page or between any paragraph in any other section in the notebook proved to be a very grounded and in-depth analytical procedure, facilitating comparison of sources, prioritising, theming etc.

The screenshot shows a OneNote interface with a navigation bar at the top containing 'PTDC-MHC-CED-5116-2012', 'Home', 'Journal', 'Library', 'Case studies', 'Survey', 'Graphic novels', and 'Teacher Training Programme'. The main content area is titled 'The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis' with a date of '18 August 2015' and time '17:04'. Below the title, there are two columns of text. The left column is titled 'Existing research on aspects of learning environments' and contains two paragraphs from page 119. The first paragraph discusses the 'Naturalness principle' and lists environmental parameters: 'light, sound, temperature, air quality and links to nature'. The second paragraph discusses the 'Individualisation principle' and lists parameters: 'Ownership, Flexibility and Connection'. The right column is titled 'Geographical/national context' and contains a paragraph from page 120 stating 'All investigated schools are in Eng climate due to its proximity to the of a prevailing westerly wind.' Below this paragraph is a 'voice comment' icon and the text 'voice comment' and 'Audio recording started: 1'. The paragraphs are linked, as indicated by the small blue icons and lines connecting them.

Fig. 14 - In the Literature review matrix, paragraphs of text can be linked between each other, tagged for task management or coded as in a QDAS.

In the DRN we also created custom tags, like codes, that would be applied at a paragraph level, similar, though simpler, to coding in QDAS. This allowed us to make a tag search and extract the relevant texts across our entire library, along with the comments made on them. We could

also generate summary pages of that search. Manipulating text in this way offered deeper and better grounded insights. When we needed further detailed analysis we would resort to QDAS, but the balance between effort and depth in the DRN was adequate for many of our analytical questions.

The screenshot shows a web interface for a 'Tags Summary' page. The main content area is titled 'Tags Summary "The impact of classroom design..."' and includes a date and time stamp: '18 August 2015 22:43'. The page is organized into two main sections:

- 01 PHYSICAL**: This section contains two paragraphs. The first paragraph discusses the climate of England and its proximity to the Atlantic Ocean. The second paragraph discusses flexibility in classroom design, with a highlighted segment: 'there is a focus on how to make a personally optimized built environment that can benefit a pupil's learning process and behaviour.' Below this is a sub-section: 'Any theory on personalisation_'
- 02 PERSONAL**: This section contains two paragraphs. The first paragraph discusses the 'Naturalness principle' and lists environmental parameters: 'light, sound, temperature, air quality and 'links to nature''. The second paragraph discusses the 'Individualisation principle' and lists parameters: 'Ownership, Flexibility and Connection parameters.' A highlighted segment reads: 'Ownership is the first element and is a measure of both how identifiable and personalized the room is.' Below this is a sub-section: 'Personalisation is a major concept.'

On the right side, there is a sidebar titled 'Tags Summary' with a search bar and several controls:

- 'Search completed'
- 'Group tags by:' with a dropdown menu set to 'Tag name'
- 'Show only unchecked items' checkbox (unchecked)
- A list of tags under '01 PHYSICAL':
 - All investigated schools are in Englan...
 - Flexibility is a measure of how the ro...
- A list of tags under '02 PERSONAL':
 - The Naturalness principle relates to t...
 - The Individualisation principle relates...
- 'Search:' dropdown set to 'This page group'
- 'Refresh Results' button
- 'Create Summary Page' button
- 'See also' section with a 'Customize tags' link

Fig. 15 - Codes can be searched and coded segments can be collected in a Tags Summary page.

Interviews

We developed a walkthrough interview schedule that provided a spatial agenda for participants to respond to. We wanted to elicit the practices associated to the key design elements of the SLS, and contrast them with the idealised model. This meant that the interviews took place in the actual studios, where the interviewer and interviewee could directly interact with space and objects. The interviewer used a visual checklist that defined a route through the studios, with some key stops where questions would be made.

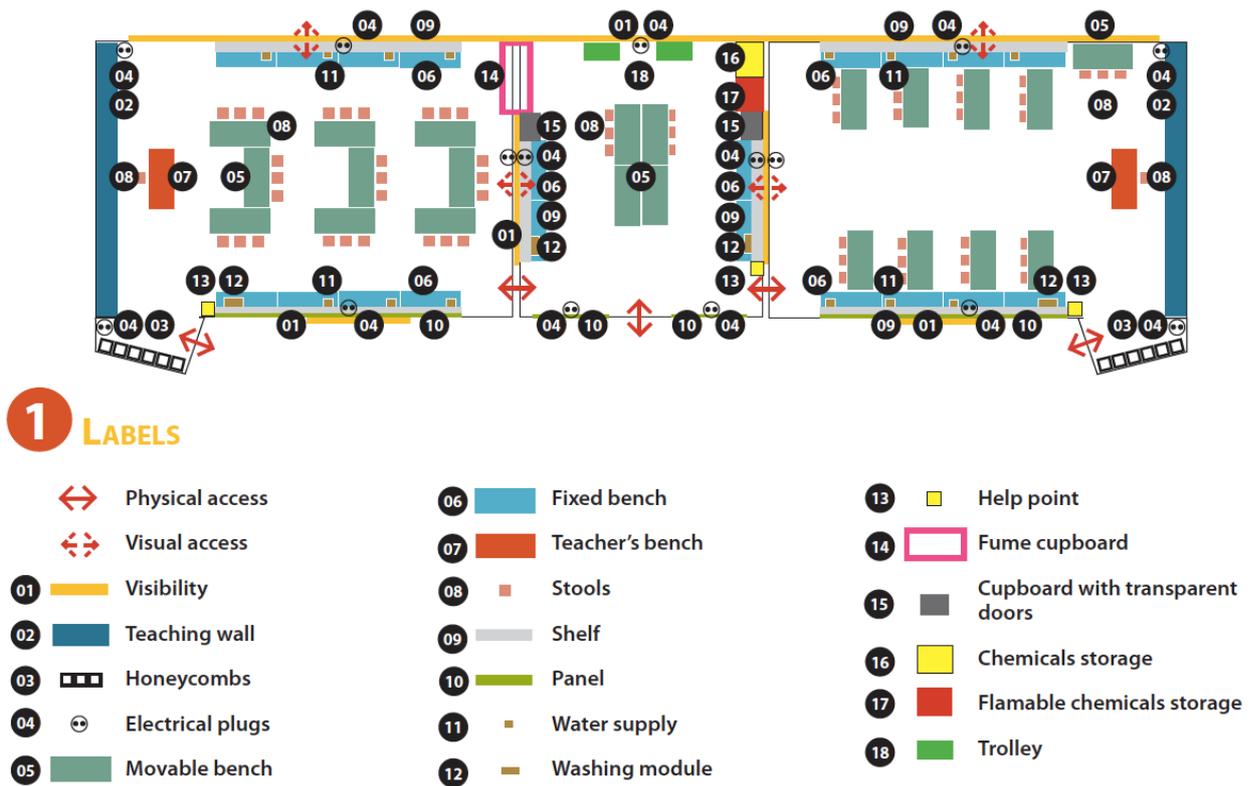


Fig. 16 - Key elements of the SLS drove the interview route.

Collecting audio and handwritten notes in an integrated way

This kind of interview meant that interviewer and interviewee were constantly moving in both the studio and prep room, exploring, changing the space or demoing some applications, while:

1. Recording the interview (audio);
2. Taking photos;
3. Taking handwritten notes;

The pilot interviews and photos were recorded with a mobile device and handwriting notes in a paper notebook.

The immediate problem arising from this was the difficulty in linking all these data. They were usually stored in a folder by file type and interview date, if in a digital format, or linearly in the field notebook on paper, with post-its acting as separators. So, how to make them manipulable in a common working space for research purposes?

We developed a Handwriting template in our DRN that could be used with a tablet and pen by the interviewer during the interview process. The interview schedule was at hand in the same section to help the process. In this template we would directly record the audio of the interview, include photos taken and handwrite our notes. The information was in this way kept all in one place and usefully synced. This meant that when we played the audio recording, the handwritten note taken at the time of the capture would become highlighted (and vice versa).

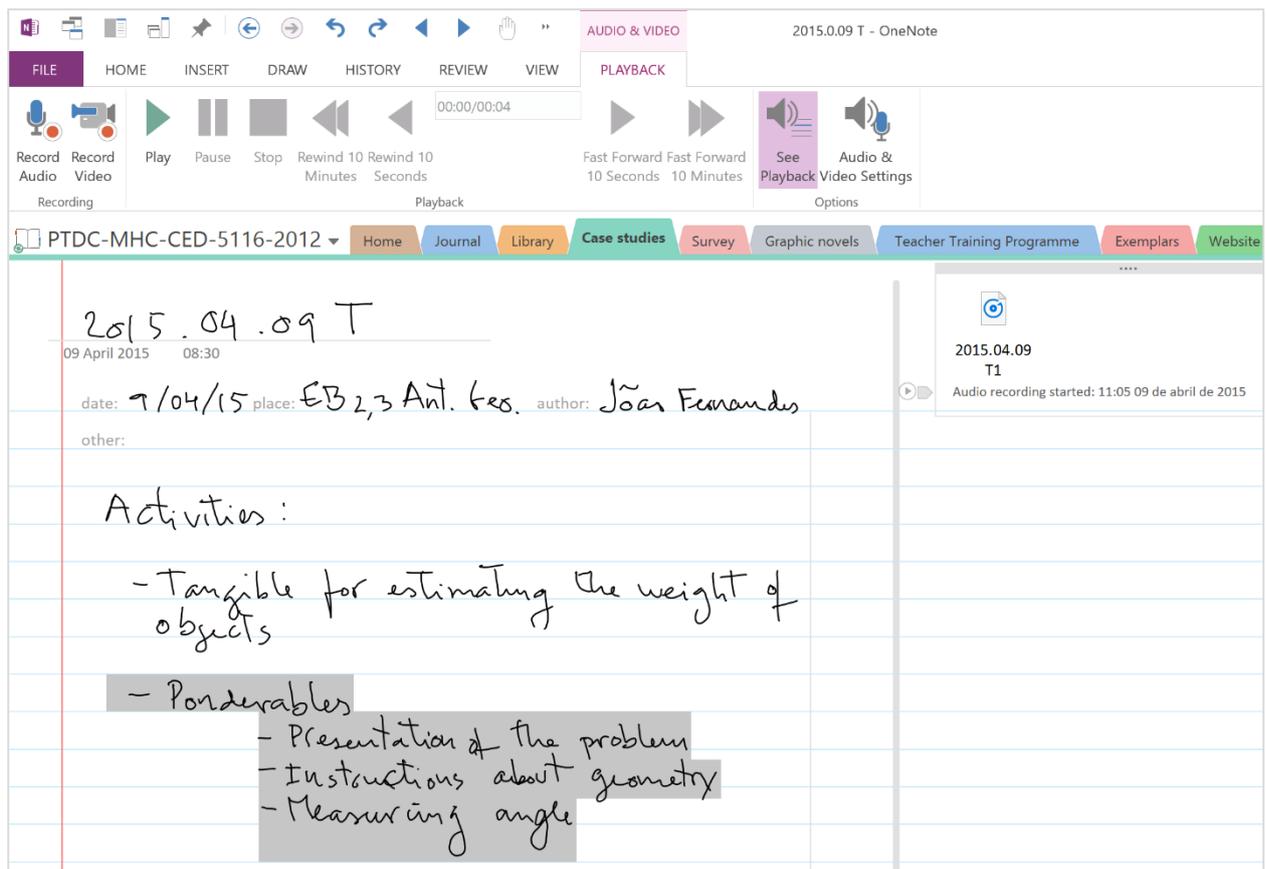


Fig. 17 - In an Interview, handwritten notes were captured and synced with the audio.

To recover some old interview data, we devised a workflow to easily scan notebooks with a mobile device, using Office Lens, and then add them to the DRN. We also tested a smart pen that writes in paper but can send all the text and drawing to OneNote. All the digital handwriting could be accurately converted to text in the application.

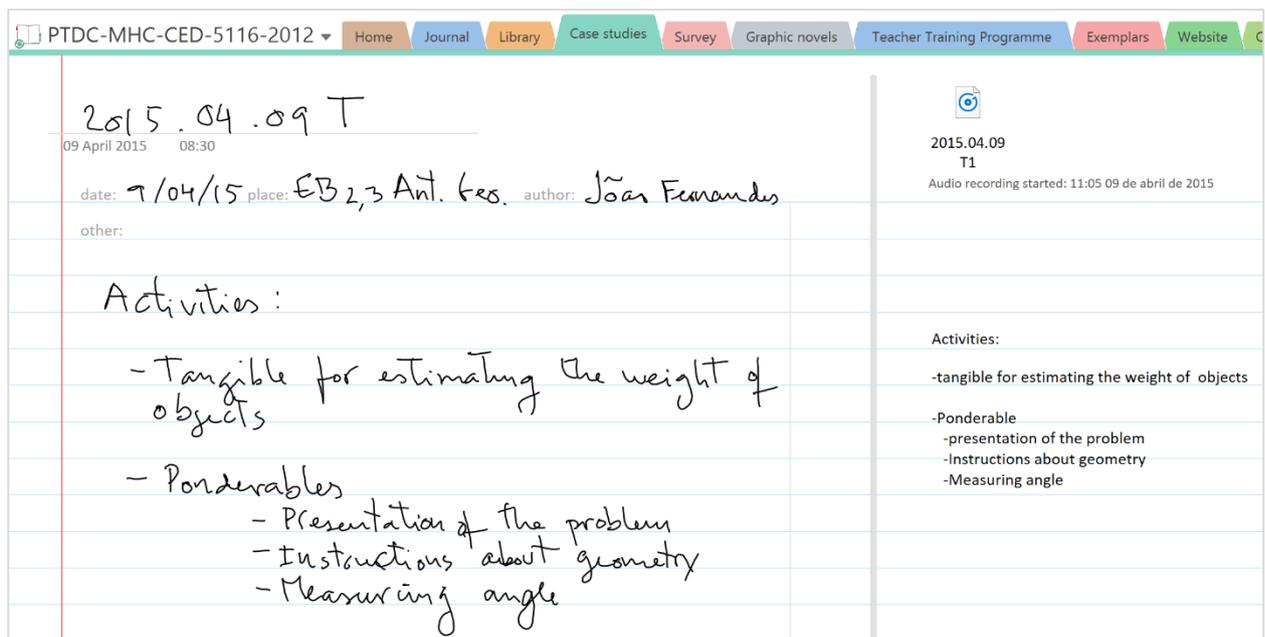


Fig. 18 - Handwritten notes can be accurately converted to text with the "Ink to text" function in OneNote.

Though working with paper and digital was quite difficult at the start of the process, mixing paper and digital workflows through DRN became quite manageable.

Transcribing the interview

OneNote provides a basic interface to support transcribing of audio or video interviews. We can play the recording forward and backward, jump to a specific time tag, and in this way transcribe the entire interview. We can later sync the transcription with the audio by simply adding paragraphs to the text in the moment we were listening to it. With this syncing in place, when we played the audio again, the corresponding text would be highlighted and if we played the text (a small play button is added to each paragraph), we could listen to the matching audio. This made it much easier to quickly access the context of the talk while doing analytical work.

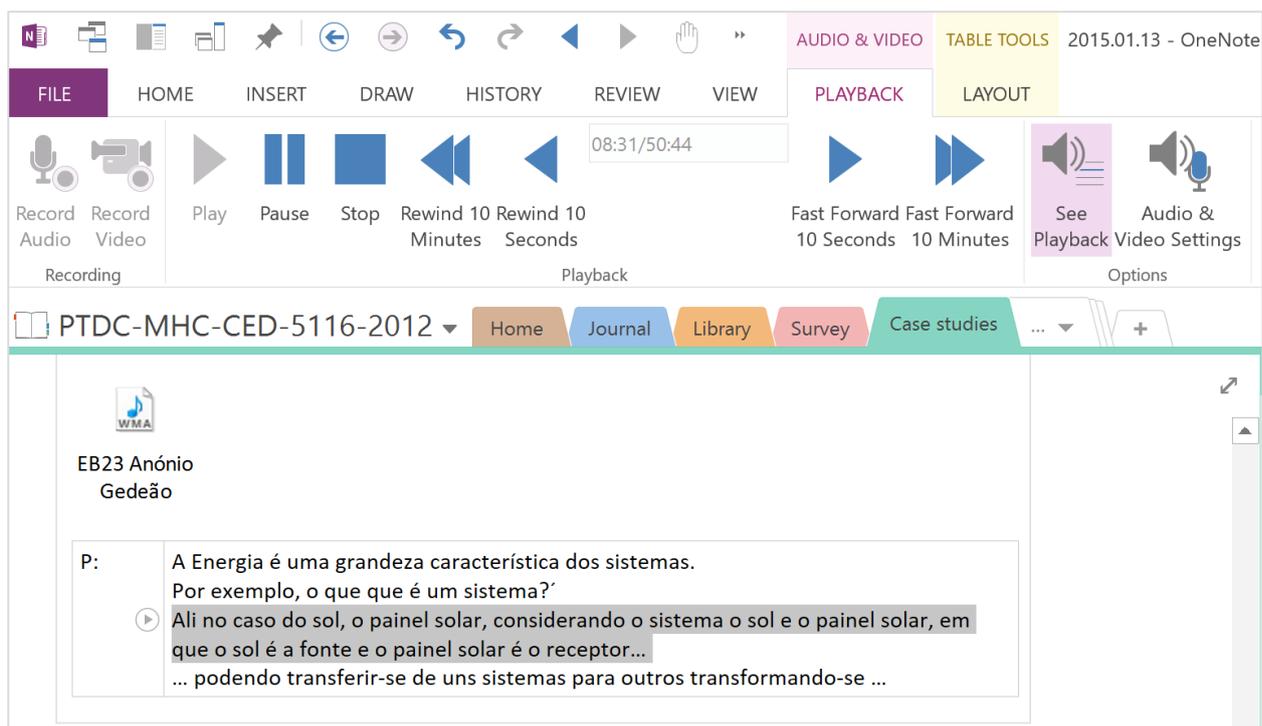


Fig. 19 - Audio can be synced with the transcription. When the audio is played, the corresponding transcription is highlighted and vice-versa.

From this transcription we could apply all the features of OneNote such as tagging, searching and linking, providing more opportunities to ground our overall research work.

Classroom observation

The goal of classroom observations in our project was to analyse activities using a Science Learning Studio Activity Analysis Methodology. In this section we will show you how we collected multimedia data in a Digital Research Notebook in an integrated way, processing it and finally generating a Pedagogical Graphic Novel, a kind of storyboard of classroom activities.

Collecting data in a coordinated way

In the pilot phase of the project we began generating data from classrooms using a camera to record video and take some photos, and registering observation notes using Evernote.

A significant problem with this data collection process was the difficulty in syncing the available data in a common timeline without some considerable effort. We had photos in one folder, video in another and notes yet in another place. Handling large video files and doing collaborative analysis was also very demanding.

Our vision for classroom observation was of a meaningful process not only to us, but also to students and teachers. For pedagogical and professional development purposes, we also thought of classroom observation as an opportunity to produce shareable outputs of real classroom practice. To address all these challenges, we designed a participatory workflow for producing Pedagogical Graphic Novels.

A workflow for producing Pedagogical Graphic Novels with Digital Research Notebooks

From our previous experiences using storyboards to capture classroom activity, we decided to produce a graphical output of the classroom observation, to easily communicate classroom activity, in both paper and digital formats.

We revised the storyboard concept and reframed it as Pedagogical Graphic Novel.

We still needed to design a workflow easy enough to sync the several data types (notes, photos, audio/video and files), allow analysis and generate a flexible output, keeping its participatory and collaborative nature.

The first step was to provide one student with a tablet with internet access and instruct him/her to capture classroom activity, by taking photos and writing captions on a DRN page. We were connected to this same page in another device, recording classroom audio.



2015.11.30 10CT3 Turno 2 (A)

30 de novembro de 2015 11:03

Densidade relativa de metais

Resumo do conteúdo da atividade
Data de publicação: 30/11/2015
Autor: [nome não legível]

FQ10 CT3, Turno 2
2015.11.30 11:00-13:30

Sumário:
Aula laboratorial 1.3

4 grupos de 3-4 alunos cada
G1 - Bancada 1
G2 - Bancada 7
G3 - Bancada 9
G4 - Bancada 6

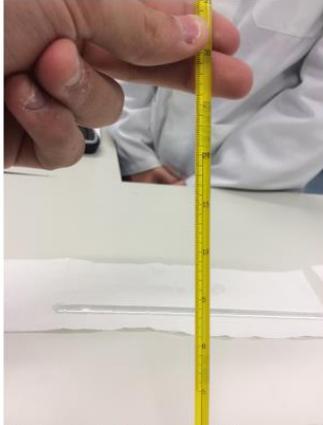


2015.11.30
10CT3 Tu...

Audio recording started: 11:05 30 de novembro de 2015



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Medir a temperatura do picnómetro com o metal (20,1)

Fig. 20 - Students capture vignettes of activity during class, adding photos and captions.

In this way we could follow the student's capture in real-time, and give him/her just-in-time feedback on the relevance and quality of the capture.

By the end of the class, we would review the photo capture and captions made by the student, cropping images in the DRN to focus its key aspects and composing them into a Graphic Novel template.

Finally, we would sync the audio with the captions so that when we played the audio, the text would be highlighted and vice-versa.

We also created links from parts of the text to data collected in other formats (for example, PDF files or PowerPoints used in class), or transcribed certain interactions, providing more detail to the graphic novel.

2015.11.30 GN ESACF FQ10 CT3-T1 AL 1.3

2 de dezembro de 2015 13:00

AL 1.3

Densidade relativa de metais

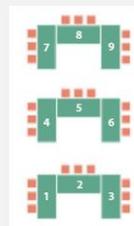
FQ10 CT3, Turno 1
2015.11.30 08:25-11:00

Sumário:

Aula laboratorial 1.3
Discussão e apresentação por parte dos alunos

5 grupos de 3 alunos cada

- G1 - Bancada 1
- G2 - Bancada 4
- G3 - Bancada 8
- G4 - Bancada 6
- G5 - Bancada 3



2015.11.30
Turno 1 (A)

Audio recording started: 08:52
30 de novembro de 2015

Autores: João Pereira, Margarida Gaspar, João Fernandes 2015.12.04

A. Introdução da actividade

01



Os alunos entram e colocam as mochilas e casacos nos favos ao fundo do laboratório, levando para as bancadas apenas o material necessário e a bata vestida.

02



03



Fig. 21 - The Pedagogical Graphic Novel integrates several modalities in a flexible format.

This first draft of the Pedagogical Graphic Novel was then edited with the teacher. Besides correcting it, we discussed particular aspects of the activity relevant to the research project and identified the issues that could be raised when discussing the novel with the class.

In the class following the recorded one, we would project the graphic novel in class and analyse and review the activity collectively, with the vignettes framing the discussion. During the discussion, more changes were done to the novel.

This workflow finished with publishing the graphic novel in PDF and paper formats. For that, we developed a template in OneNote formatted to print in an A3 paper size in landscape mode. With one click we exported it to Word, where we added page breaks, page numbers or headers, and then exported the final result to PDF or print. The novel had as authors the student, the teacher and the researchers.

Survey

In this section we will describe how the survey in the research project was developed, illustrated and shared in a DRN.

Defining the survey questions

We wanted to integrate themes from several surveys to have a reference to which to compare some of the results. We also wanted to link our current research, namely the case studies, to the survey design.

We began by using Word to prepare an early draft to start iterating versions. We pasted several questions from different sources, our own ideas from the research questions, and tried several structures with heading styles. This file would then be shared between the team, usually in a cloud service, and commented and worked upon.

We felt some difficulties in dealing with the linear flow of text of a word processor in this conceptual stage so we started using DRN to compare and sort interesting questions from previous surveys. We copy/pasted them from PDF into a Canvas template designed for this end, in which they could be easily put side by side, zoomed in and out and combined with other

modalities other than text. We could also have different OneNote pages opened side by side which allowed a much easier comparison between questions and the Canvas with the overall design ideas.

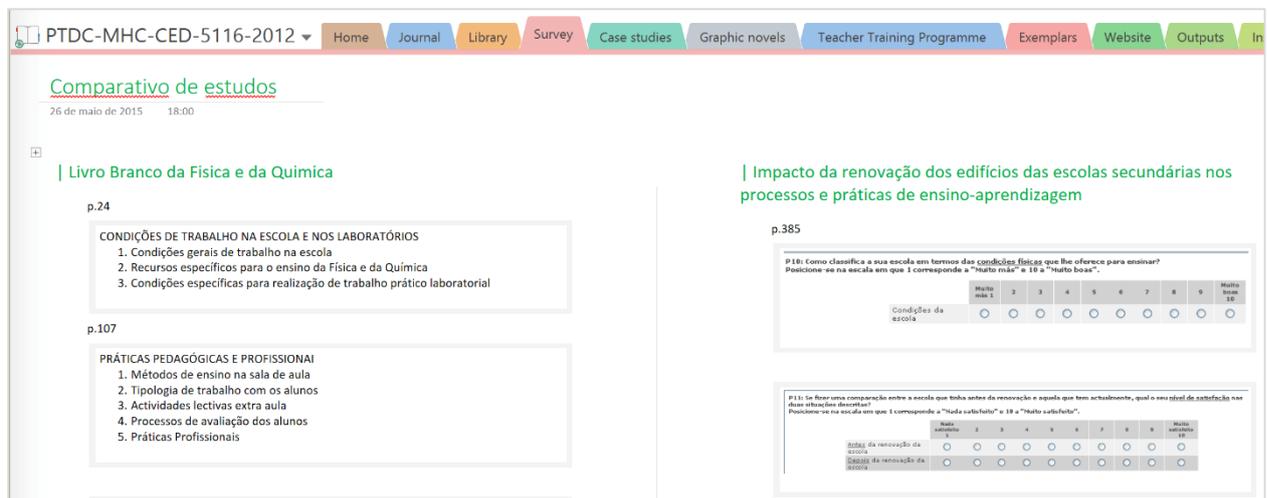


Fig. 22 - We used the Matrix template to compare different studies that informed the survey questions' design.

We began iterating drafts in OneNote using the outline feature to comment on each question. This made collaboration easy between the team to get to the final version before validation.

Illustrating elements of the survey

We planned a visual approach to the survey, with illustrations and photos of classroom activity that could help respondents to reflect on their own practices.

Our survey was applied to teachers from 106 schools intervened by Parque Escolar. The questions were organised in 5 categories: 1) Basic data on the respondents; 2) Use of the new SLS; 3) Teaching and learning activities in the new SLS; 4) Experience during the intervention by Parque Escolar; 5) Detailed data on the respondents.

Photos from graphic novels were the obvious content for section 3 of the survey. But in section 2, we wanted to show diverse situations of the SLS in use, so that respondents could have a concrete situation to respond to.

Initially we made several experiments with a 3D model of the new SLS in Google Sketchup. The goal was to assess the practicality of a workflow to create short illustrated activities in the SLS. The initial process was somewhat complex - define the framing in Sketchup and export pictures, printing in paper, draw upon characters and objects and scan the result. This was not practical.



Fig. 23 - After exporting a framing in Google Sketchup as a picture, we would print it, illustrate it and finally scan it.

So we began some experiments using digital ink in OneNote to create simple characters and objects, which would then be overlaid on the Sketchup frames. This proved to be a simple workflow. We could also reuse characters in other illustrations.

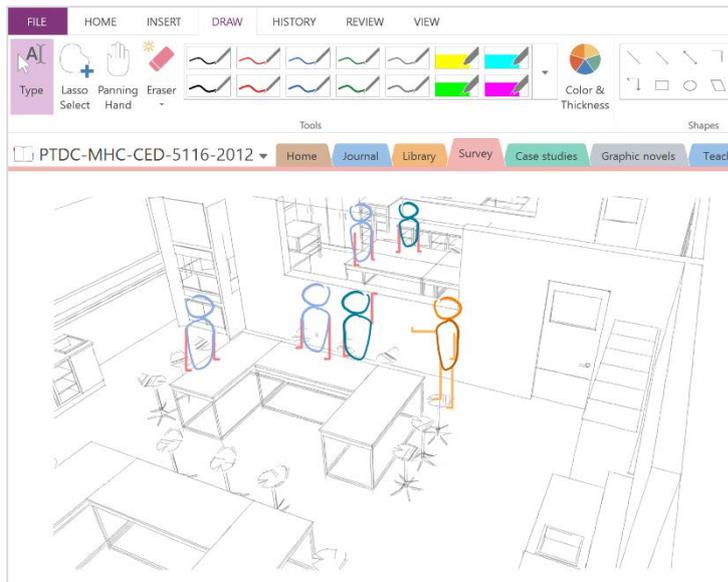


Fig. 24 - Drawings, free form or geometric, can be made in OneNote with great accuracy using a stylus.

Making the dataset and design process open

From the start, we wanted to make the raw data and the results from this survey available to both respondents and the wider research community. Our initial strategy was to use the survey software features to share the results automatically with the respondents and later, to make the data and results available in an open repository.

We used SurveyGizmo to manage the email campaign, deliver the online survey and report on the results. This tool had the possibility to share with respondents both their individual responses and the results' report.

For the remaining stakeholders, we used the DRN to share the dataset (embedded as an Excel file), the data analysis reports (PDF), the outputs (as papers) and the development process, from survey design to validation and implementation (a set of OneNote pages).

PTDC-MHC-CED-5116-2012 ▾ Home Journal Library Survey Cas

Dataset 2015.07.21

30 de setembro de 2015 16:00

 20150721101140-SurveyExport(1)

Distrito:Qual	Concelho:Qu	Escola:Qual	Em que ano	Durante quan	Física e Quím	Biologia e Ge	Outro::Qual	é C
Portalegre	Ponte de Sor	Escola Secur	2010/2011	8		Biologia e Geologia (520)		
Porto	Póvoa de Var	Escola Secur	2009/2010	15	Física e Química (510)			
Porto	Matosinhos	Escola Secur	2008/2009	11	Física e Química (510)			
Lisboa	Mafra		2010/2011	4	Física e Química (510)			
Leiria	Leiria	Escola Secur	2010/2011	1		Biologia e Geologia (520)		
Aveiro	Espinho	Escola Secur	2011/2012	12	Física e Química (510)			
Porto	Porto	Escola Básic	2009/2010	5		Biologia e Geologia (520)		
Évora	Évora	Escola Secur	2009/2010	20	Física e Química (510)			
Setúbal	Almada	Escola Secur	2009/2010	20	Física e Química (510)			
Porto	Lousada	Escola Secur	2010/2011	5		Biologia e Geologia (520)		
Porto	Santo Tirso	Escola Secur	2012/2013	5		Biologia e Geologia (520)		
Leiria	Leiria	Escola Secur	2010/2011	6	Física e Química (510)			
Braga	Braga	Escola Secur	2012/2013	15		Biologia e Geologia (520)		
Porto	Penafiel		2009/2010	3	Física e Química (510)			
Braga	Guimarães	Escola Secur	2009/2010	15	Física e Química (510)			
Lisboa	Mafra	Escola Secur	2011/2012	6	Física e Química (510)			
Porto	Porto	Escola Básic	2009/2010	10	Física e Química (510)			
Porto	Porto	Escola Secur	2009/2010	11		Biologia e Geologia (520)		
Santarém	Salvaterra de	Escola Básic	2010/2011	23		Biologia e Geologia (520)		
Braga	Braga	Escola Secur	2009/2010	15	Física e Química (510)			
Setúbal	Almada	Escola Secur	2009/2010	22		Biologia e Geologia (520)		
Lisboa	Odivelas	Escola Secur	2009/2010	1		Biologia e Geologia (520)		
Lisboa	Lisboa	Escola Secur	2008/2009	13	Física e Química (510)			
Lisboa	Lisboa	Escola Secur	2008/2009	18		Biologia e Geologia (520)		
Lisboa			2010/2011	1		Biologia e Geologia (520)		
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Fig. 25 - The survey dataset can be shared in a DRN by embedding the Excel file on one of its pages. The spreadsheet can be opened with just one mouse click.

Final remarks

In this case study we went through the application of a new concept, the Digital Research Notebook, to a Science Education research project. We tried to show you some concrete dilemmas in our everyday research lives and how DRNs helped us solve some of them. Looking beyond the technical details and paraphernalia, the impact we most value in our research was that it made many of our research activities more efficient, while allowing in practice our values of doing research in a collaborative, participatory, grounded, reflective and open way.

Our vision of an open science is one that goes beyond communicating only research results. Making accessible the processes of research is fundamental for the quality, ethics and responsibility of Research in Society. We believe that Digital Research Notebooks can be a way of achieving these ends.

The DRN resulting from this project is available in <http://laboratorioscolares.net/ptdc-mhcced-5116-2012>.

Exercises and discussion questions

Exercises

Go to <http://onenoteinresearch.com/explore-a-demo/> and download a demo of a Digital Research Notebook. Explore the notebook which illustrates the first week of a research project.

After becoming acquainted with what can be done with it and how you might do it, try to work with your own information and construct a Digital Research Notebook for your research. Here are some challenges to get you started:

1. Organise your Digital Research Notebook by sections that represent your research design: e.g. "Literature review", "Field data", "Institutional", etc.;
2. Extract text from relevant articles from your Library and paste it in a page. Now try to explore the "link to paragraph" function to connect paragraphs of text in different pages;
3. Organise part of your bibliography in the Library section using the library collector template;
4. Take meeting notes at the same time that you record its audio. Explore the syncing feature between audio and notes;

5. Share your notebook and write a text synchronously and asynchronously with a colleague to get acquainted with the collaborative features of OneNote;
6. Customise a couple of tags to organize your content. Use the Find tags feature and generate a summary report;
7. Install OneNote in your mobile phone, open the Digital Research Notebook and take photos, capture audio or take notes on the go.

Discussion questions

1. What practical problems do you encounter in coordinating the diversity of activities in your research projects?
2. What possibilities do you envision in Digital Research Notebooks applied to your own research?
3. Grounded, participatory, collaborative, open research... Which one best fits your views on research? Can the Digital Research Notebooks help you foster any of these?

Further readings

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2. Paulus, T., Lester, J. and Britt, V. (2013). 'Constructing hopes and fears: A discourse analysis of introductory qualitative research texts'. *Qualitative Inquiry*, 19(9).
3. Simonsen, J., & Robertson, T. (eds.) (2013). *Routledge International Handbook of Participatory Design*. Routledge.

4. Bartling, S. & Friesike, S. (2014). *Opening Science*. Springer. doi 10.1007/978-3-319-00026-8
5. Fernandes, J. (2008). Science Learning Studios. In UIED, *Anais Educação e Desenvolvimento 8*. Almada, Portugal: Universidade Nova de Lisboa.
6. Fernandes, J., Teodoro, V., & Boavida, C. (2009). *Schools' science laboratories: flexible spaces for active learning – Key features*. Almada, Portugal: Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa.

Miscellaneous web resources

1. <http://onenoteinresearch.com>
2. <http://www.onenote.com/>
3. <http://laboratoriosescolares.net/ptdc-mhc-ced-5116-2012>
4. https://www.researchgate.net/profile/Joao_Fernandes36/publications
5. <http://dirtdirectory.org/>
6. <http://studysites.sagepub.com/qdas/>
7. <http://www.surrey.ac.uk/sociology/research/researchcentres/caqdas/>
8. <https://www.vitae.ac.uk/doing-research/open-research-and-open-researchers>

References

1. Lewins, A., & Silver, C. (2014). *Using software in qualitative research: A step by step guide*. London, UK: SAGE.
2. Miles, M.B. & Huberman, A.M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. London, UK: SAGE.
3. Paulus, T., Lester, J. and Dempster, P. (2014). *Digital Tools for Qualitative Research*. London, UK: SAGE.

4. Beichner, R. J., Saul, J. M., Abbott, D. S., Morse, J., Deardorff, D., Allain, R. J., Bonham, S. W., et al. (2007). Student-centered activities for large enrollment undergraduate programs (SCALE-UP) project. *Research-based Reform of University Physics*, 1(1), 2–39.

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