# From word-clouds to video: IT tools in the service of learning

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## 1 INTRODUCTION

Since the reorganisation of Portuguese higher education brought about by the introduction of the Bologna Process in the academic year 2006-07 (DGES) the authors have been working with a variety of technological instruments to enhance learner engagement and promote active learning. In the process a pedagogical framework has been developed and we have found Wenger's technology stewardship concept (Wenger, White and Smith, 2009) to provide a useful perspective on technology in the service of teaching and learning. Believing that this approach can be useful to other EER practitioners and to illustrate the relevance in guiding decisions regarding technology enhanced learning, the authors present here five examples of initiatives which they have introduced when teaching subjects of an undergraduate civil engineering course.

## 2 METHOD

### 2.1 Research questions

To assist the work of engineering faculty who work with technology to encourage student engagement, the authors set out to see if Wenger's technology stewardship approach, one originally developed in the field of learning communities, can be usefully applied in the field of engineering education research (EER). The question could thus be formulated: how can the concept of technology stewardship play a useful role in guiding technology choice decisions in EER?

### 2.2 Technology Stewardship

With the increasing emphasis on Quality Assurance in European higher education (Quality Assurance and Accountability) and a rapid proliferation of IT technology and tools which make claims to help achieve this, engineering educators here have been increasingly faced with decisions relating to tool design and selection – issues described by Wenger, White and Smith (2009) as falling within the domain of technology stewardship. Trayner (2007) originally described technology stewards as "those who know both the local context and needs, who know the technology market, and know how to weave together the two” and this definition has been expanded by Wenger, White and Smith (2009) in their recent book Digital Habitats as follows: “Technology stewards are people with enough experience of the workings of a community to understand its technology needs, and enough experience with technology to take leadership in addressing those needs. Stewardship typically includes selecting and configuring technology, as well as supporting its use in the practice of the community”.

Many engineering educators may recognize this as describing a growing portion of their professional activity although in the engineering education domain we would also want to include tool design as part of the remit of technology stewards. Since the publication of Digital Habitats in 2009 (Wenger, White and Smith, 2009) the concept of technology stewardship has begun to be applied in a variety of learning communities but we are unaware of work to date in the field of engineering education. Various authors have referred to the dangers of making technology selection decisions which are not grounded on sound pedagogical foundations (Bates and Poole, 2003 and Laurillard, 2009). A strength of Wenger’s approach is that he places learning at the centre of the process and an analysis of learning needs as the first step from which subsequent decisions about technology will flow.

When applying the concept in the engineering education context, the authors chose to characterize technology stewardship as a process in the service of teaching and learning that involves the design, adoption or adaptation of educational technology and the subsequent facilitation of its use. This paper presents five applications of the concept in technical subjects of an undergraduate civil engineering course, three involving adaptation of technology along with one example of adoption and one of design.

### 2.3 Technology stewardship in Practice

Six exemplars are presented. In the first, the authors describe how word-cloud software can be integrated in an LMS to facilitate the implementation of *muddiest point* reflection by individual students. Next they describe the selection of online self and peer assessment applications where they consider three options: SPARK$^{PLUS}$, WebPA and an open source LMS and describe how they have used one of these: the commercial application SPARK$^{PLUS}$. By contrast the adaptation of Moodle for self and peer assessment is demonstrated in the subsequent example.

Then an instance of how an online LMS can be adapted to facilitate student peer voting in a civil engineering subject is outlined and data obtained over three semesters is presented. This is followed by a brief description of the use of a graded video preparation activity to encourage and assess inter-group collaboration.

Finally the design and development of the Learner Activity Monitoring Matrix (LAMM) used to monitor student activity in the lecture classroom is presented and examples are given to show how the data obtained from this approach can be used by faculty members and departments aiming to make the traditional lecture class more effective as a learning environment.

The paper closes with conclusions regarding the usefulness of the technology stewardship concept in EER and indicates planned future research areas.

### 1. *Word Cloud for Muddiest Point Reflection – technology adoption and adaptation*

Classroom-based active learning techniques have been shown to improve student engagement and conceptual understanding (Prince, 2004) and a commonly used activity is the *muddiest point* reflection (Felder & Brent, 2014) whereby the instructor stops 2 minutes before the end of a lecture class and asks the students to write down the muddiest (least clear) point(s). The papers are collected, the responses check for understanding and the class begins by addressing the most common questions.
This method does have two disadvantages in that it can be time-consuming with large student numbers and it does not lend itself to convenient gathering of data.
However with the advent of mobile devices and LMS and the ready availability of word cloud (or tag cloud) software (Krause et al. 2013) it is now possible to implement the muddiest point reflection in a format which is easier to implement and interpret by instructor and students and allows more agile treatment of data.
In the author's case the free tag cloud generator Tagul was used to imbed the students muddiest point word cloud reflections in the institution's LMS (Moodle). This made the word-clouds weekly which encourage student formative reflection and allowed the instructor to tailor part of the subsequent the following class session to clearing up conceptual difficulties.


**Figure 1 Word-clouds produced after classes dealing with trellis structures and force diagrams**

### 2. *Student Self and Peer Assessment – technology adoption*

The use of collaborative groups in a curriculum unit is a common practice adopted by instructors because of the important competences acquired from the related activities. However, the contribution of each student within a group cannot always to be assessed. Beside the more traditional activities involving curriculum content, each the student was expected to assess their own and their peers' performance. SPARK$^{PLUS}$, an online tool designed to facilitate the use of self and peer assessment developed by the University of Technology Sydney and hosted on their server, was employed for this within the context of collaborative group-work outside and inside the classroom.
A three-stage procedure was applied:

- Stage 1: Group preparation of whole-class presentation – a group of four to five students prepare a short presentation on a topic proposed by the instructor;
- Stage 2: Theme Presentation – the group presents the topic in the classroom;
- Stage 3: Self and Peer Assessment – using the SPARK$^{PLUS}$ application students assess their own contribution and performance and that of their peers in the group.

The development of competences involving judgement skills and peer evaluation is promoted and with these activities students are encouraged to reflect on their own and their peers' contribution to teamwork and at the end SPARK$^{PLUS}$ calculates two factors: SPA which is a measure of the contribution of each member to the work of the team and SAPA the ratio of a student's own rating of themselves compared to the average rating of their contribution by their peers. These two factors are available for consultation by individual students and the instructor.

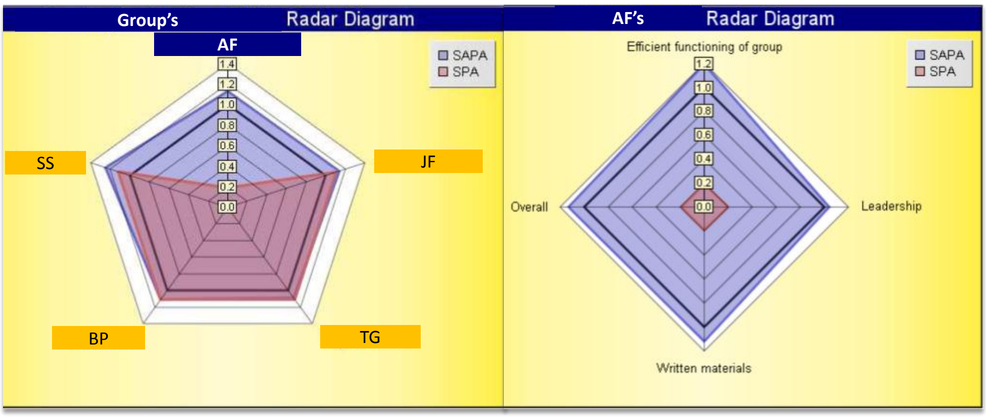


**Figure 2: Contribution within the group and individual response according to the criteria**

An advantage of this application is that it outputs data in various formats including individual student and group radar diagrams and in Excel format thus facilitating statistical analysis. For example, a study by Beamish, Kizil, Willey and Gardner (2009) at Queensland University suggests that academically stronger students tend to underestimate their own contribution (rate themselves lower than they are rated by their peers) and vice versa.

The application aims to reduce the probability of collusion between group members in evaluating each other by providing rating via a slider rather than simple numerical or Lickert scale and it also facilitates the identification of students aiming to beat the system and allows the instructor to exclude them from the marking process.

### *3. Student Self and Peer Assessment – technology adaptation*

Another tool with some common purposes, i.e. student peer and self-assessment, was implemented. Although the ideal tool for this part of the process would be a dedicated online application like WebPA or SPARK$^{PLUS}$, which the authors had previously used, it was decided to explore the possibility of adapting a commonly installed LMS to achieve the same purpose. This can be achieved by adapting the quiz function found in Moodle 1.0.

A six-stage procedure was applied:

- Stage 1: Student sign-up – this is an optional activity which if completed contributes to the final subject mark;
- Stage 2: Ice breaker task to get familiar with the online interface;
- Stage 3: Group preparation of a report – a group of four to five students prepare a short report on topics proposed by the instructor;
- Stage 4: Peer revision – a revision of the report is done by a different student group;
- Stage 5: Group preparation of the final version of the report – students prepare the final version of the report after the suggestions made by their peers;
- Stage 6: Self and Peer Assessment – using the online self and peer assessment application students assess their own contribution and performance and that of their peers in the group.

The LMS self and peer assessment application does allow the instructor to export data into Excel but overall the procedure requires a greater time investment than would a dedicated applications like WebPA or SPARK$^{PLUS}$ (Neto, Williams and Carvalho, 2010).

### 4. Peer voting procedure using an online LMS – technology adaptation

It was felt that there was a need for additional practice in resolving quantitative technical calculations in a range of contexts as in exams of previous years it was noted that students often had difficulty when confronted with applications of learned procedures in less familiar contexts. Accordingly an Online Learning Management System was used to provide learners with additional practice in critical analysis and allow them more flexible time management.

The survey function commonly found in LMS such as Moodle or Blackboard allows one to increase learner engagement with the material under study by introducing a peer voting process. This is essentially an online application of what Paulson and Faust (2007) refer to as Active Review Sessions – “In the traditional class review session the students ask questions and the instructor answers them. Students spend their time copying down answers rather than thinking about the material. In an active review session the instructor poses questions and the students work on them in groups. Then students are asked to show their solutions to the whole group and discuss any differences among solutions proposed”. The online asynchronous implementation has the additional advantage that it allows more time for learner reflection than conventional review.

A three-stage procedure was applied:

- Stage 1: Individual problem solving - students were given a statement online and had a week to post a justified comment to that statement. Once students post their answer they can see those of others. The solutions remain online but cannot be altered;
- Stage 2: Peer Selection – Individual critical analysis - students are allowed a week to vote for the best solution posted;
- Stage 3: Completion – the lecturer comments on the winning solution and gives a model answer. A symbolic prize may be awarded to the most successful contribution.

The benefit of this procedure is that it increases student engagement by encouraging them to compare their own solutions to the questions posed by the lecturer with those of their peers. The students’ participation level for stage 1 of a first question achieved a value near of 90% of the maximum number of students attending to class This aspect reveals an important participation level although a decrease is observes along the semester (as well as class attendance) which is strongly dependent on external factors like tests and assessed assignment deadlines for other curriculum units (Neto, Williams and Carvalho, 2009).

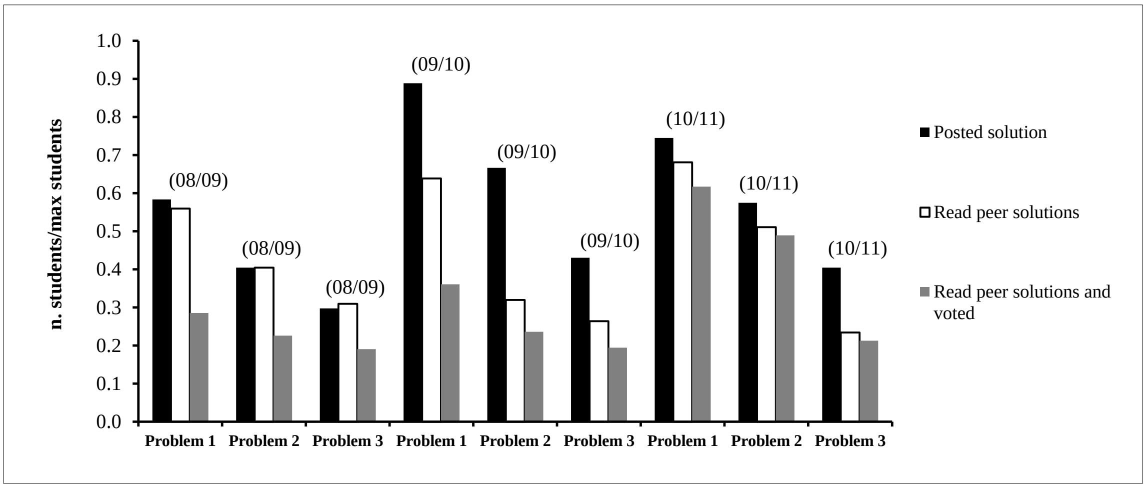


**Figure 3: Contribution within the group and individual response according to the criteria**

From the last three years, where these measures started to be applied, allied with AL techniques in classroom, the average attendance registered during the last five weeks of the semester came from 1.2 to 1.4 times higher than the corresponding values obtained in 2007/08. With respect to the success rate, when comparing the academic years from 2007/08 until 2010/11, an increment of 15.5%, 13.7% and 14.0%, respectively, was observed. Thus, from the data collected it is possible to verify a favourable effect on both student engagement and success rates

### *5. Inter-group collaboration to produce short videos – technology adaptation*

In this evaluated activity, each of 15 groups studying Analysis of Isotactic Structures was given a topic related to the material under study and had to prepare a script for a video presentation (10 min maximum) which will be created by another group. The group composition was instructor-determined and the first group activity was an ice-breaker where each group had to post a pitch in Moodle advertising their academic and creative qualities. The overall process is set out in figure 2. After inter-group negotiation, Group A's script is accepted by Group Y while Group A accepts a script from Group X. Each group then prepares the video based on their chosen script.

The final mark for Group A is weighted 80% for the video created by A and Y and 20% for the video created by A and X. The marks of individuals within the group were further refined in accordance with their self and peer rating calculated using SPARK$^{Plus}$.

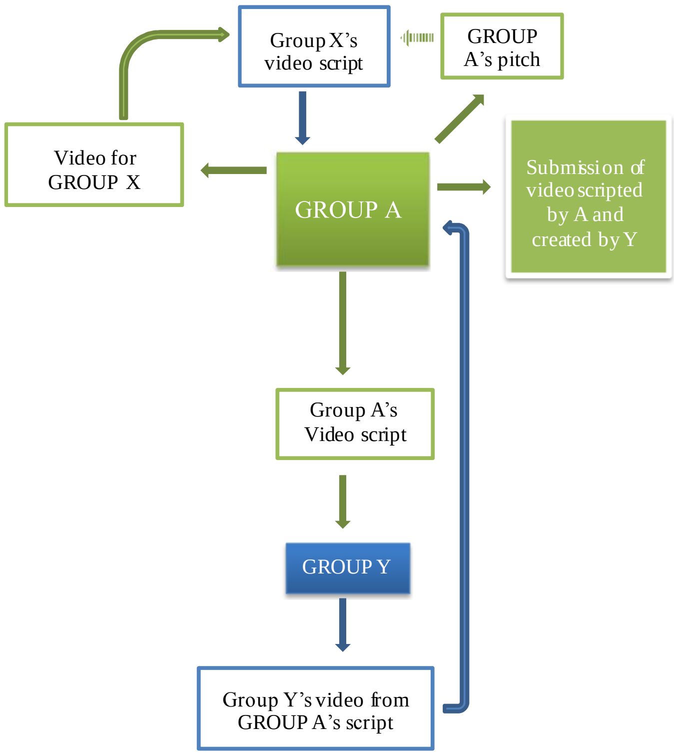


**Figure 4: Procedure for inter-group collaborative preparation of a 10-minute video presentation**

Of the 15 groups originally involved in this evaluated but optional activity, 10 completed the process and submitted videos for evaluation. These were made available online for all students in the group.

### *6. Learner Activity Monitoring Matrix - technology design*

Several in-class activities from two online activity banks (Felder and Brent, 2007 and Paulson and Faust, 2007) were adapted. From these lists a few activities were selected to be used in a variety of course contents, namely: In-Class Teams; Think-Pair-Share; Minute paper; Regular uses of students' names; The "One Minute Paper"; Muddiest (or Clearest) Point; Affective Response; Clarification Pauses; Wait Time; Discussion; show of hands voting; active review sessions, and student revision lists. The implementation of in-class active learning techniques can be monitored using a Learner Activity Monitoring Matrix (LAMM) which we have designed for the purpose. This is a simple semi-quantitative matrix created in Excel file and uses in-classroom observation or post-class video observation to monitor the degree of student activity during the implementation of AL techniques in their classes. It also allows an individual instructor or team to focus on the question of learner activity during class contact time and develop efficient techniques to increase it. More detailed information on the use of the LAMM and its use to generate an Activity Index and Participation Parameter for each observed lesson can be found in previous publications (Carvalho and Williams, 2009 and Neto, Williams and Carvalho, 2009).

L.A.M.M. - Learner Activity Monitoring Matrix

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Course | Civil | Lecturer | BW | Location | EST Barreiro | Other | |
| Class | CVN11 | Timetable | 18.00 | Date | 03-05-2010 | | |
| Room | 0.04 | Observer | ND | | | | |

| Time | Minutes | Listening to lecturer or other other student | Resolving exercises/ problems (individual) | Checking/ comparing awswers | Pair discussion or other pair-work | Group work (>2) | Distracted | Other | Nº of students | Spontaneous learner contribution (X) | Learners respond to individualised question (Y) | Learners respond to whole-class question (z) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.30 | 2 | 1 | | | | | | | 20 | | 1 | |
| 10.31 | 4 | 1 | | | | | | | 20 | | 2 | |
| 10.32 | 6 | | 1 | | | | | | 21 | | | |
| 10.33 | 8 | | 1 | | | | | | 23 | | | |
| 10.34 | 10 | | 1 | | | | | | 23 | | | |
| 10.35 | 12 | | 1 | | | | | | 23 | | | |
| 10.36 | 14 | | 1 | | | | | | 23 | | | |
| 10.37 | 16 | | | 1 | | | | | 23 | 1 | | |
| 10.38 | 18 | | | 1 | | | | | 23 | | | |
| 10.39 | 20 | 1 | | | | | | | 23 | | 2 | |
| 10.40 | 22 | 1 | | | | | | | 23 | | 2 | 1 |
| 10.41 | 24 | 1 | | | | | | | 23 | 2 | 1 | |
| 10.42 | 26 | 1 | | | | | | | 23 | | | |
| 10.43 | 28 | | | | 1 | | | | 23 | | | |
| 10.44 | 30 | | | | 1 | | | | 23 | | | |
| 10.45 | 32 | | | | 1 | | | | 23 | | | |
| 10.46 | 34 | | | | 1 | | | | 23 | | | |
| 10.47 | 36 | 1 | | | | | | | 23 | | | |
| 10.48 | 38 | 1 | | | | | | | 23 | | | |
| 10.49 | 40 | 1 | | | | | | | 23 | 1 | 4 | |
| 10.50 | 42 | 1 | | | | | | | 23 | | 1 | |
| 10.51 | 44 | | | | 1 | | | | 23 | | | |
| 10.52 | 46 | | | | 1 | | | | 23 | | | |
| 10.53 | 48 | | | | 1 | | | | 23 | | | |
| 10.54 | 50 | | | | | 1 | | | 23 | | | |
| 10.55 | 52 | | | | | 1 | | | 23 | | | |
| 10.56 | 54 | 1 | | | | 1 | | | 23 | | 1 | |
| 10.57 | 56 | 1 | | | | | | | 23 | | 1 | |
| 10.58 | 58 | 1 | | | | | | | 23 | | | |
| | 60 | 1 | | | | | | | 23 | | | |
| Weight | | 1 | 2 | 2 | 3 | 3 | 0 | 0 | 682 | 1 | 1 | 0.5 |

Comments

| | |
|---|---|
| Activity index | 58 |
| Participation Parameter | 19.5 |

**Figure 5 Learner Activity Monitor Matrix**

Table 1 show an example of evolution the Activity Index (AI) and Participation Parameter (PP) values collected for 22 observed lessons of an individual lecturer who was introducing active learning techniques into her lecture classes (an AI value of 30 corresponds to a lecture where learners are essentially passive listeners throughout the class).

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AI | 30 | 50 | 37 | 57 | 37 | 38 | 37 | 50 | 54 | 30 | 30 | 38 | 55 | 33 | 32 | 38 | 35 | 31 | 52 | 56 | 33 | 31 |
| PP | na | 3 | 8 | 11 | 7 | 8 | 25 | 29 | 17 | 16 | 11 | 12 | 18 | 21 | 22 | 16 | 27 | 13 | 0 | 0 | 14 | 13 |


**Table 1: LAMM results for an individual instructor**

Overall, the instructor's perception of increased learner activity and engagement over the period under study is clearly reflected in the semi-quantitative data obtained from the LAMM-registered observations (Neto, Williams and Carvalho, 2009). The use of AL techniques seems to have a favourable contribution to the attendance as shown in previous work (Neto, Williams and Carvalho, 2009). Although these initial results represent a relatively small population, it is interesting to see that they reflect findings from other studies involving Active Learning and Audience Response Systems (clickers) which reported improvements in attendance when student activity in

lectures was recorded by clicker responses (although only in cases where this activity contributed to more than 5% of the final grade) (Caldwell, 2007).
Analysing the data obtained from the use of the LAMM in 107 observed lecture classes, Table 2 shows a comparison between the % time engaged in lecturing (i.e. students passively listening) for both AL-oriented and traditional lecturers in our study.

| Lecturers | % lecture time |
|---|---|
| AL oriented (n = 92) | 62 |
| Traditional (n = 15) | 93 |

**Table 2: LAMM results comparing Al oriented and traditional lecturers**

## 3 CONCLUSIONS

In the work presented here the authors have mainly aimed to illustrate how they have found this particular conceptual approach to be useful in guiding their own practice. In the contexts presented, the type of framing recommended by proponents of the technology stewardship approach has proved valuable in approaching decisions concerning technology in the service of teaching and learning and can provide a useful framework for EER practitioners to approach technology decisions because it stresses the prior definition of learning needs and aims to cultivate a learning community approach among faculty. Furthermore, an approach based around the design, adoption or adaptation of technology provides a perspective that can prove attractive to engineering specialists not hitherto involved with EER who are likely to be familiar with such decisions in other contexts.
On the other hand, the authors are conscious that the six exemplars presented here are essentially descriptions of classroom based initiatives and as such would benefit from being submitted to a more granular data-based analysis. The authors are now at the stage of defining the data needed and establishing appropriate strategies, including statistical and phenomenographic procedures, to gather data to validate the approach more fully.

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