Reducing Procrastination in Class: A Wiki-powered Experiment with Students

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***Abstract*—As part of their curriculum, students in higher education are traditionally requested to produce various pieces of written work during the modules and courses that they undertake. Vivas, oral examinations or common-room exams are not always possible, especially for online courses. When students' work is submitted online as a whole, aspects that affect to performance, like procrastination or late submissions, are not trivial to address. The objective of this paper is to assess the performance of students in terms of time management. A *control* group produced the work as a unique piece of work, in six parts, to be submitted at the end of the course. On the other hand, the *experiment* group worked on each part for six weeks, and their work was managed by a wiki environment and monitored by a specifically developed software system. A positive effect was noticed in the experiment group, as the time management skills increased significantly, with less resulting late submissions. Replications of this experiments can and should be performed, in order to compare approaches and results in coursework submission.**

***Index Terms*—Procrastination; wikis; monitoring; time management.**

I. Introduction

Students in higher education are traditionally requested to produce various pieces of work during the modules and courses that they undertake. The need for authenticity in the assessments, to protect the true identity of a student against their work, has long been recognised as in contrast with the requirement of delivering computer-based assessments [1]. Personally attending a viva, or sitting in an exam classroom are normally the adopted solutions, with the latter being a preferred option, given a reported lack of reliability of vivas [2]. More in general, vivas, oral examinations or common-room exams are not always possible or practical, especially for online courses and institutions. The adverse effects of anxiety have been recognised to impact on the performance of students during oral examinations [3].

On the whole, when students' work is submitted online, a teacher is typically only able to assess the final deliverable, and not the process that the student undertook to produce the result. In such a scenario, getting students to work steadily, limiting procrastination and improving their time management skills is not usually under the control of the educator. In fact, time pressure is identified as one of the students' reasons to justify plagiarism [4], an increasing problem in higher education [5].

When investigating procrastination, Ariely and Wertenbroch [6] show that working by self-imposing deadlines helps people to control the procrastination habit. In fact, Allevato and Edwards [7] offered 10% extra credit for delivering a handout three days before the deadline, with no results, concluding that the problem was the poor time management of students. However, Hfner et al. detected that students with good self-regulatory skills procrastinated less than those in the control group [8].

Allowing students to work in a supervised environment, and helping them to break down the tasks of an assignment could be beneficial in the time management aspect. Using clearly sign-posted milestones would keep the whole work in check before the final deadline. Learning tools can be leveraged to do so: online environment tools offer sandboxes, collaborative benchmarks and tracking systems that can be easily deployed in an academic environment to help students take responsibility of their work [9]. In particular, the users of a wiki can collaborate in order to develop topics or concepts: the wiki environment keeps a log of every contribution from each user to any wiki page. In a scholarly context, and posing subsequent milestones, a wiki environment can be used to monitor the time management of students.

This work reports on the experiment carried out with two cohorts of students undertaking a Computer Science course at Brunel University London (BUL), UK. A wiki environment was set up for students to work on a number of tasks: although the final deliverables were individual, collaboration between students was encouraged. A monitoring tool was developed to check that students comply with the time limits. The time management outcomes of the students undertaking this experiment was compared to what was observed within the previous year's cohort of students in the same module. The objective was to evaluate the deployed wiki environment as a treatment to avoid procrastination and late submissions.

The rest of the paper is organized as follows: in section II previous works have been evaluated. Section III explains the experiment, introducing the hypotheses and the experiment design; while section IV illustrates the main features of the tool that was implemented to monitor the activities of the students. Section V shows the results of the experiment, comparing the behaviour of the control and the experiment groups. Section VI discusses the findings and the limitations of the approach, while section VIII concludes.

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II. Related Work

A negative relationship between procrastination and performance was found in several works. Learners' participation was measured from the number of messages posted in a forum concluding that students with high procrastination tendencies may learn through observation, whereas those with low procrastination tendencies prefer to learn by participating with others on discussion forums [10]. In fact, there is strong positive correlation between studentstudent interactions and grades in individual assessment of teamwork activities [11]. Another paper proposes complementing indicators from a virtual learning environment with 'time to' variables to assess learning activities, as these variables are related to negative forms of procrastination [12].

Students' interaction patterns in virtual learning environments are related with their performance. In a recent paper, students were clustered by their behaviour from the records of a Moodle-based course [13]. The results confirm that the procrastinating students are characterized by the lowest grades. Besides, the analysis of the variable related to procrastination indicated that the students who handed in the task later are more likely to receive a lower score. Therefore, an intervention to combat procrastination might be beneficial. The paper presented by Johnson et al. [14] reinforces the aforementioned hypothesis, since they showed how procrastination decreases as explicit rules are established.

Procrastinators perform poorly in highly structured, web-based courses with frequent enforced deadlines [15]. When wikis are used to support learning experiences, the tasks to be developed by students in their pages are usually subject to deadlines [16]. These experiences based on wikis are common in higher education as they facilitate collaboration among students [17]. But even if students do not collaborate in the development of a wiki-based work, simply being aware of their mates progress in completing their work encourage students to complete their work in time [18]. Teachers can use the history function in the wiki system to monitor students task completion [19]. For this purpose, a monitoring tool to collect data related to students' effectiveness (task completion) and efficiency (task in time) is required [20].

III. Experimental Design

This section presents the goals and hypotheses, and gives a description of the experiment following the guidelines of the American Psychological Association [21].

A. Goals

The goal of the experiment is to compare the work produced by the *control group* of students who worked on a traditional assignment, submitted 'as a whole' at the end of the semester, with the work produced by the *experimental group* of students, who worked on a series of tasks monitored by an extended wiki tool. The purpose is to evaluate the work of the two groups in terms of their time management towards a specific deadline (i.e., the submission date).

B. Research Questions

In traditional settings, courseworks are typically handed in by students as one large document, with the teacher setting a deadline and asking the students to submit their work before it. This approach is brittle to time management issues: students tend to work according to fixed deadlines, and the vast majority will produce their work very close to the final date [22]. From a teacher's perspective, it is difficult to identify and acknowledge students who managed their time better, or even contribute to classmates' assignments.

The research question derived from this context is: "*By monitoring the work of students through non-invasive tools, how effective is the usage of milestones and intermediate tasks towards the time management of the students?*".

The research question was formalised into the following null hypothesis (H_0): the presence of a monitoring tool, used by teachers to evaluate the time management of students, will encourage students to work on time. Fewer students in the *experiment group* will deliver their work late, as compared to the students in the *control* group. The alternative hypothesis (H_1) states that there are no differences in how the two groups handle the time management for delivering the coursework.

The metric used to evaluate this hypothesis is the number of assignments handed-in late in each group.

C. Experiment Design

A standard design with one factor and two treatments was used [21]. The treatments correspond to the two approaches: (i) coursework with controlled steps (experiment group); and (ii) coursework submitted as a whole (control group), as described in section III-E.

D. Participants

The participants of the experiment are two cohorts of students from the Computer Science and Information Systems degrees at BUL, attending the same module. The control group is the cohort of students from 2013-14 of the *Software Development and Management* module. The experiment group is the 2014-15 cohort of students of the same module. The module requires students to learn concepts and techniques to analyse and produce more consistent software. The first cohort consists of 185 students, the second one had 166 students.

For both the control and experiment groups, no prerequisite knowledge was required to perform the tasks, i.e. lectures and tools provided what was needed to produce the work in the assignment. A one-off lecture was provided to the experiment group on the features of a Wiki platform. Also, two mock sessions were run to help students familiarise with the Wiki environment and syntax, before the actual tasks were recorded and assessed.

E. Settings and Experiment Tasks

The lab rooms were equipped with 90 PCs running standard Windows operating systems. In order to fit all the students, the experiment group was split in two sessions, of two hours each.

The two sessions were hosted on the same day of the week (Friday) in two adjacent time slots (2-4 pm and 4-6 pm).

The MediaWiki server was hosted outside of the lab session, but still within the premises of BUL, so only students within the campus could access the wiki pages. This prevented interferences by external users. MediaWiki version 1.19.14 was installed on a standard Ubuntu GNU/Linux server.

In the following subsections, the apparatus of the control and experiment groups are discussed.

F. Courseworks

In both the control and experiment groups, the courseworks were worth 50% of the final mark, the rest of the mark being evaluated with an examination in term 2. Both courseworks were divided in six parts. Albeit the courseworks required students to work on slightly different aspects, as described below, the parts of the two courseworks were mapped to similar Learning Outcomes (LO). The context of the two courseworks was also the same: the analysis of real software systems, based on the extraction of metrics via software tools. It is important to notice that, since the tasks are not comparable one-to-one, such a test was not performed: the comparative analysis was performed on the outcomes of the two courseworks, rather than their parts, since the two courseworks have a comparable level of complexity.

Control group The coursework of the control group required students to select an open source project from a list of available projects. All the projects were hosted, at the time of selection, under the GoogleCode open repository, and they were all coded in Java. A list was populated with 1,000 projects with at least 20 Java files of source code.

The students had three months to produce a final coursework with the content of six parts. Each part required to analyse the project from various perspectives, extracting metrics and reporting the findings. Lab sessions were provided to support each of the six parts composing the assignment, but the attendance was not mandatory.

Experiment group Each student was given a unique ID to access the Wiki server, and a single monolithic open source system (FreeCol[1]) was partitioned in files and classes. Each student received 3 Java source files, and 7 binary classes that became the object of the analyses in the six parts of the assignment. Students were requested to create their wiki user page, and, each week, to create and link new pages based on each task number. All the reports, metrics and discussion were required to be hosted under the task of the week.

As previously commented, all students in the wiki could read the pages created by other students. Each student was assigned an individual and unique piece of code to analyze and had to reflect on the individual results obtained. Additionally, the history of changes in each page is publicly available, so the teacher has an overall view of the progress of the class. As a contrast, reading all the pages could had a positive effect on students who had problems with their task: they could read the work that others were doing to get insights of what they were expected to do. Moreover, if they detected the wrong content, they could fix it and get recognition for it.

[1]http://www.freecol.org/

TABLE I
LEARNING OUTCOMES (LO)

LO1	Identify, explain, and evaluate the key concepts in software engineering (including architectural and design methodology, patterns and notations).
LO2	Analyse a real software systems from three points of view: the users, the developers and the managers of its development.
LO3	Translate design models into a range of software artifacts (namely program code of three or more languages, types or tiers).

TABLE II
LISTS OF TASKS

Task	*Control Group*	*Experiment Group*
I	Identify the domain (LO2)	use ckjm tool on files and classes, copy and paste results (LO2)
II	List the functions of the system of choice (LO2)	identify dependencies of classes, copy and paste graphs (LO2)
III	Size and staffing using TortoiseSVN (LO1)	Size and staffing using TortoiseSVN (LO1)
IV	Effort estimation (LO2)	SVN vs Git (LO2)
V	UML translation I (LO3)	Effort estimation (LO1,LO3)
VI	UML translation II (LO3)	UML translation (LO3)
Worked on	*System chosen by the students*	*Source files and classes assigned earlier*

There were other reasons for contributing to other students' pages. If a student finished their task early, they would help populate and restructure common pages that all the students needed (for instance, the list of packages, developers and so on). Concerning this, students were warned that each student was responsible of the content in their wiki page. This way, they had to implicitly decide how to handle the contributions in their pages: leaving them if considered correct, modifying them if completed but needed improvement, or directly removing them if they are not interesting (this could imply reporting the supervisor if they are considered intentionally wrong). As a result, the collaboration benefits both students: the *helping student* implicitly contrast their approach to solve their task with that from other students. Conversely, the *helped student* has to properly integrate the contribution in their coursework.

G. Procedure

The assessed LO were made known in advance, according to the standard format in use at BUL. They are summarised in table I and they are common for the two groups.

Control Group – Students in the control group had the opportunity to learn the techniques, metrics or tools needed for the coursework during the lab sessions. The six tasks, as summarised in the first column of table II were due in a unique final hand-in, at the end of the semester.

Experiment Group – Regarding the experiment group, the students received general instructions on Wiki editing. Two practical sessions (two hours each) were run beforehand to practice with the format, editing and basic syntax wiki skills.

After those, six sessions were run and used as tasks for the coursework as indicated in the second column of table II.

Students were told that their actions were monitored by a versioning system embedded in MediaWiki, in order to give credit to the owner of each task. The monitoring tool allowed the teacher to check whether students did the tasks in their Wiki pages during the time slot established for each group. This way, late work was discouraged: if students worked outside the allotted time, a cap was applied to their work, in terms of maximum marks for each task. A minimal (5%) amount of work was permitted on top of the allotted time, but a proportional decrease of marks was made known to the students, had their work exceeded the time given. This is in line with any other piece of work that students might submit late during their academic life, so it is assumed that students were comfortable with the rule.

H. Experiment Variables and Formalized Hypotheses

The main independent variable of the experiment is group affiliation. It indicates whether a participant belongs to the experiment (the whole coursework due in one submission) or control (the coursework split in monitored tasks) group.

The main dependent variable is the performance of the students in the sessions. The performance is defined as the level of participation and understanding of students in a taught module. The number of late submissions is well-suited for measuring the time management of each group.

IV. WikiAssignmentMonitor (WAM)

WikiAssignmentMonitor (WAM) is an open-source[2] tool specifically developed for this case study. WAM is implemented as a PHP web application that queries a MediaWiki database. It provides the instructor with objective indicators of the students' work in a MediaWiki environment.

WAM diplays a web application with several sections: when setting it up, instructors can create *groups* of students, attending specific *sessions*, while monitoring their *time management*. As shown in Figure 1, the groups are defined by the teacher, and students are assigned to one or more groups. Groups are assigned specific lab sessions: WAM allows an instructor to create the links: student → group → lab-session.

In the *time management* section of WAM, instructors can obtain two types of reports for a *group* of students: *work per session* and *work per hour*. The work-per-session report provides a table where each cell represents, per week, the percentage of work that each student performed within the session. The colour of the cells changes from yellow to green as long as the percentage moves from 0% to 100%.

The second report is the *work per hour*, a table that represents the hourly percentage of the work performed by each student. The corresponding time-slot for these students is enclosed by two red lines. The table has the anonymised students in each row and 24 columns, one for each hour of the day. The background-colour of the cells are painted **green** when a given student performed the majority of the task (more than 30%) in the hour indicated by the column; **yellow** if they did a significant part (between 10% and 30%) of that task; and **red** if they worked less than 10% on that task.

[2]https://www.assembla.com/spaces/WikiAssignmentMonitor

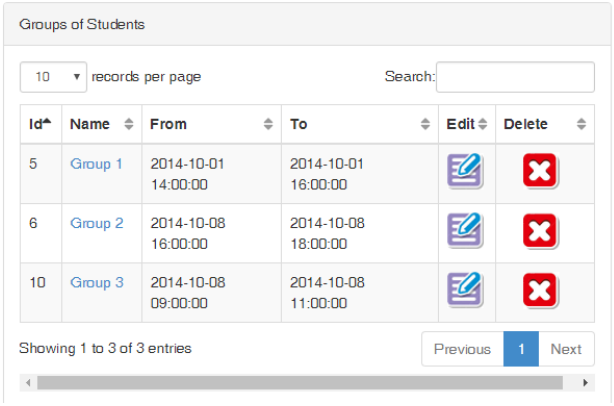

Fig. 1. Configuration of the groups in WAM

The data reflected in both reports are directly obtained from the wiki database. Thus, if the instructor changes the information of any group or any session (for instance, reflecting an extension to a deadline, or a change within groups of students), all the changes will be reflected. In addition, a CSV file is also provided with every report. Through this file the instructor can download the information and process it using a spreadsheet.

V. Results

We present below two sets of results: (i) from the teacher's perspective, V-A reports the time management monitoring results observed in the experiment group; (ii) from the students perspective, V-B tests the null hypothesis, by considering the control and the experiment groups, and checking if the amount of late submissions was different in the two groups.

A. WAM Reports (Experiment Group)

Figure 2 shows two aspects related to the work of the group. The first compares the work done by the students in the allowed session (dark bars), to the attendance to the same session (grey bars).

Considering the students' attendance, it is evident that most students were regularly attending the lab sessions since the very first one. The first and the second sessions registered around 80% of attendance, while the last four sessions had around 90% of students.

On the other hand, the work completed during the first and second session was only around 40%. Even though students knew the restrictions and the capping rule, the majority of students finished their task well over the allowed time (one week or several weeks after the lab session was over).

WAM helped the teacher to real-time analyse time management issues, addressing them at an early stage instead of waiting for marking. Observing the WAM screenshot (figure 3), the course instructor was able to determine (in a non-invasive way) this discrepancy between lab attendance and work completed.

After further clarifying the capping rule, the last four sessions the completed work increased to about 80%. Using these

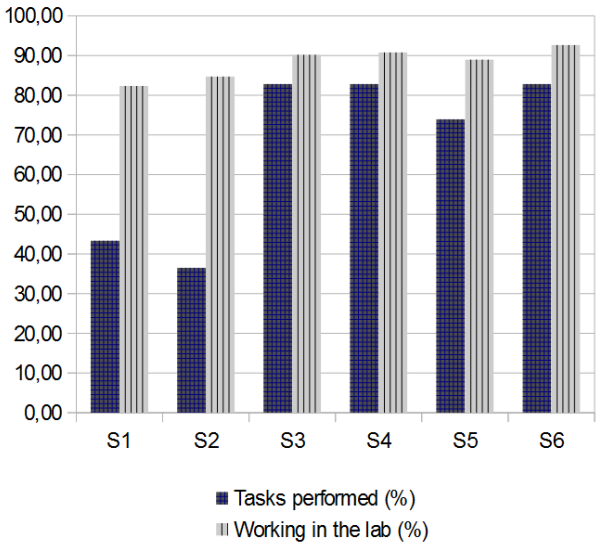

Fig. 2. Students attendance and engagement during the lab sessions

reports, the instructor concluded that the time management of students improved in the last four sessions.

Student	17/10	24/10	31/10	14/11	21/11	28/11
CS2002 001	0.00 %	100.00 %	100.00 %	59.72 %	3.65 %	100.00 %
CS2002 002	96.92 %	47.40 %	100.00 %	100.00 %	100.00 %	100.00 %
CS2002 003	85.79 %	1.70 %	100.00 %	100.00 %	100.00 %	100.00 %
CS2002 004	21.39 %	46.76 %	100.00 %	100.00 %	100.00 %	100.00 %
CS2002 005	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
CS2002 006	66.12 %	82.20 %	100.00 %	100.00 %	100.00 %	100.00 %
CS2002 007	98.71 %	0.00 %	100.00 %	92.71 %	99.12 %	18.06 %
CS2002 008	50.07 %	100.00 %	53.44 %	100.00 %	100.00 %	99.66 %
CS2002 009	100.00 %	0.00 %	100.00 %	0.00 %	29.07 %	100.00 %
CS2002 010	71.30 %	1.38 %	100.00 %	100.00 %	100.00 %	100.00 %

Fig. 3. WAM view of work completion

B. Time Management: Control vs Experiment Group

The *control* group had to submit their work as a whole, and before a known deadline, without further check-points. The observations on their time management were as follows:

1) **Late submissions**: 30 students handed in their work after the deadline passed. Three of them claimed extenuating circumstances, due to personal problems, therefore decreasing the number of late submissions to 27.
2) **Retakes**: Three students retook the module exam in the summer, either because they failed the second part of the assessment, or because they did not agree with the mark given in the first instance.

The *experiment* group had to wrap up their tasks into one document to be submitted before a known deadline. This process was based on a print-out of all the Wiki pages produced by each student, and submitted as one coursework.

1) **Late submissions**: It was observed that only 4 students handed in their work later than expected. No student claimed for specific extenuating circumstances.
2) **Retakes**: No students retook the module in the summer, therefore agreeing to the marks given in the first attempt.

As far as the definition of the research question, and the formulated hypothesis, the null hypothesis could not be rejected: the time management of the students in the experiment group was more effective than that of the students in the control group, as far as the amount of late submissions. Table III summarises the findings of this first research question.

TABLE III
TIME MANAGEMENT: CONTROL VS EXPERIMENT GROUPS

Group	Late sub's (rate)	Ext. Circ. (rate)	Retakes (rate)
Control	30 (16%)	3 (2%)	3 (2%)
Experiment	4 (2%)	0 (0%)	0 (0%)

VI. Discussion and Post-Hoc Analysis

The findings above show two types of results: from a *teacher* perspective, the WAM tool can be an effective tool to provide an early warning for single students, or the whole cohort, if they are lagging behind in terms of work before a deadline. From the *students* perspective, our results show a positive effect when using a wiki environment (i) to monitor their own time management, and (ii) to prevent the procrastination of work in delivering a (multi-part) coursework. The effect was measured by the drastic drop in late submissions by the experiment group, as compared to the control group.

It is worth reporting that the experiment was not easy to deploy. Students were used to a certain type of coursework, as deployed the year before, and they expected something along the same lines. Students showed a good amount of resistance that had to be reconciled by pointing out the basic rules of individual assignment. The attempt at clearly and uniquely pointing out the responsible of a piece of work was probably perceived as a limitation of how students could "play the system", but it was also recognised as a transparent method at marking students[3].

It is also worth mentioning that the means used to prevent students from working outside the allotted time, i.e., the capping applied to the grade of an over-run part, was also not easily accepted, and perceived as an unnecessary addition to the module specification. Again, BUL students were expected to be fully knowledgeable about the mechanisms of late submissions, and how this could be reducing the overall mark when handing in a piece of work outside the fixed deadline.

VII. Threats to Validity

In the following, the threats to validity are illustrated.

[3]As one student pointed out: "(...) *using the wiki as a submission medium could be one of the fairest method of judging the work someone has done*"

1) Internal validity: It should be noted that the two courseworks were not exactly the same. As visible in table II, the LOs of the various parts are similar in both tasks, thus the level of difficulty, but the exact equivalence cannot be guaranteed, given that the coursework specification was changed between the two cohorts. In order to test the null hypothesis, this is not required: our experiment is designed to test how students manage their time using two similar pieces of required work, that can be split in various, independent parts.

2) External validity: the results of the study can be generalised only in the context of the UK institution in which they were deployed, although it represents a quite common and thus generalisable setting. In order to generalise the findings to other universities, and more importantly, to other subjects, a replication of the experiment is needed.

3) Construct validity: it is assumed that the time management skills of a student can be measured by their ability of working to a certain deadline. This is an approximation, and it misses other important factors, including the quality of work, or the resulting stress. What this work measures is one of the outcomes of poor time management, if not the most visible.

VIII. Conclusion

This paper presented the results of an experiment using a Wiki environment enriched with a monitoring tool for early detection of deviations. It was observed that students in the experiment group progressed in their time management skills, resulting in less late submissions than those observed in the control group.

These findings are valuable to teachers and researchers, and may be practically adopted in any higher education degree, specifically when educators are interested in analysing the interactions between students, and when the assignment can be broken down into loosely coupled components (engineering and computing tasks in particular).

As a future work, the experience will be repeated using a richer wiki environment for assignment management aligned with actual corporate strategies [23].

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