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Project Title: Analytics for tracking student engagement

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Executive Summary

Although there has been much research in the area of data analytics in recent years (e.g. Shum and Ferguson 2012), there are questions regarding which analytic methodologies can be most effective in informing higher education teaching and learning practices (Gibson and de Freitas, 2016).
This project focuses on one module within the School of Computing and Communications in the STEM faculty to gain a clearer understanding on why students might, or might not, engage with computer aided learning and teaching (CALT) resources. We explore the use of specific CALT resources on the module 'Communications Technology', a print-based module with a range of online resources designed to supplement the text.

The research questions cover two key areas; the effectiveness of the analytics tools and students' perception of the CALT resources.

Via data analytics we can review:

- When the students engage with the CALT resources and whether this is at predicted times during the module.
- Whether students revisit the CALT resources.

Via individual student feedback we can explore:

- What motivates students to engage with CALT resources.
- Whether students understand topic more deeply as a result of using CALT resources.
- If students are deterred if the resources are too complicated/time consuming.

The findings should be of interest to module teams across many universities. This project will build on previous work undertaken in this area, e.g. Herodotou et al (2017) and Tempelaar et al (2017), and contribute to the wider body of knowledge in the area of data analytics. From an OU perspective, the findings should be of interest to those involved in other Level 3 modules in the IT and Computing degree programme i.e. TM351, TM352, TM353, TM354, TM356 and TM357.

Aims and scope of the project

The main aim of the project was to use learning analytics to uncover student engagement with computer aided learning and teaching (CALT) resources in the UK Open University module TM355 Communications Technology. This module is an elective component in the University's honours degree in Computing and IT. The module covers such topics as radio propagation, digital signal modulation, source coding, error control, optical fibres, DSL broadband and mobile communications. The module is predominantly print-based but parts of the module are supported by sophisticated CALT resources, particularly in relation to topics relating to coding and error control.

The module is studied towards the end of the students' degree level studies and introduces several complex themes. To aid study of such material, additional experiential learning (Kolb, 1984) is available via online interactive activities, designed to supplement the written materials. These are referred to within the printed materials and are added to the students' study planner, grouped together to make them relatively easy to find. An example is shown in Figure 1 below.

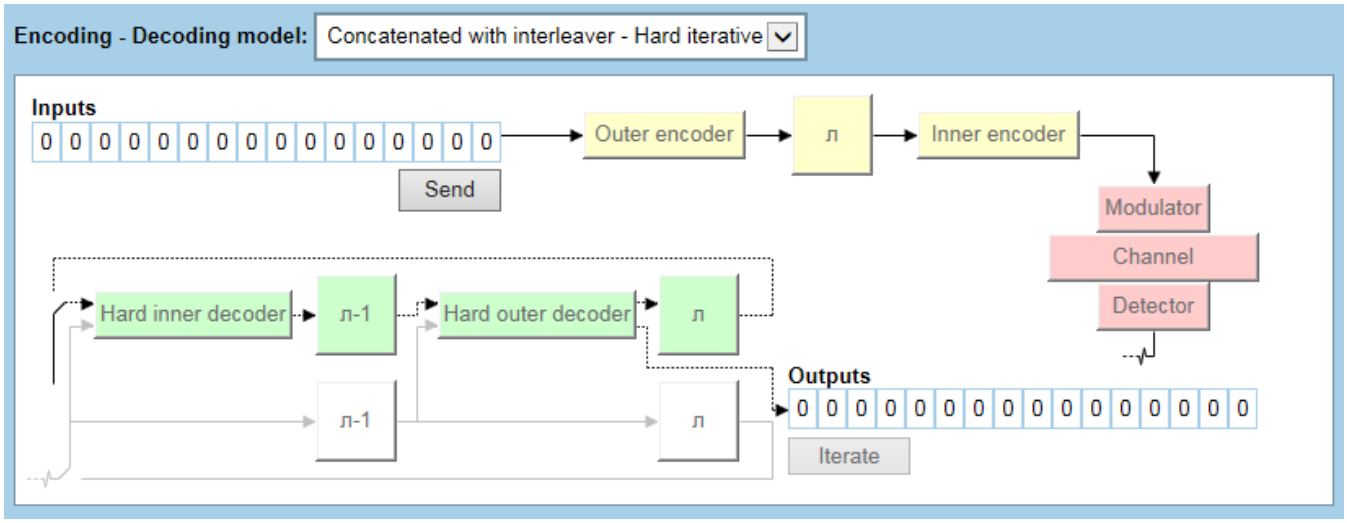

Figure 1 – Example of TM355 CALT resource (online activity)

The research was motivated by a particular examination question used in the 2017 examination. The question, on the topic of error control, was in a part of the examination paper where students had a choice of questions to answer. The question related to techniques of error control that had been taught in print, and demonstrated interactively with a CALT resource which students were strongly advised to use, but could not be compelled to use. In this study learning-analytics data was used retrospectively to investigate the use of the relevant CALT resource by students who chose to answer the question, and as an aid to framing interview questions relating to the use of CALT resources. This appears to us to be a novel use of learning analytics data

There were several specific goals:

Via data analytics we reviewed:

- When the students engage with the CALT resources and whether this is at predicted times during the module.
- Whether students revisit the CALT resources.

Via individual student feedback we explored:

- What motivates students to engage with CALT resources.
- Whether students understand topic more deeply as a result of using CALT resources.
- If students are deterred if the resources are too complicated/time consuming.

Activities undertaken

The overall approach was to observe current practice on TM355, particularly in relation to online activity. By evaluating the online engagement of students, the module team then considered if specific changes were required.

The research questions cover two key areas; the effectiveness of the analytics tool and students' perception of the CALT resources. The methodology employed a mix of quantitative and qualitative research methods, in particular the collection of data analytics and use of semi-formal interviews. Via data analytics it was possible to review when the students engaged with the CALT resources and whether at predicted times during the module. It was also possible to collect data to establish whether students revisit the CALT resources. Via individual student telephone interviews a more in-depth view could be established regarding what motivates students to engage with CALT resources, whether students understand topic more deeply as a result of using CALT resources, or if students are deterred if resources are too complicated or too time consuming.

The main data analytics tool selected for the research was Analytics for Action, A4A (Hidalgo, 2018). A4A can provide detail of how students are engaging with specific online materials. Data is presented at a high level, with the aim to provide a module-level analysis of how students are engaging with online materials. The framework for application of A4A has six phases, as shown in Figure 2, that can help module teams continually review and improve student experience by identifying specific actions to be taken.

Figure 2 – A4A six phases

A4A is a visual platform, providing a summary of student performance using real-time data. For example, Figure 3 depicts student interaction with a specific online resource that relates directly to assessed material. The vertical axis represents the number of students engaging with a CALT resource, the horizontal axis represents the study weeks of the module and the light blue vertical bar represents an assignment due date. It can be seen that peak use of the related online resource ties in with the submission of the second assignment, due in week 20.

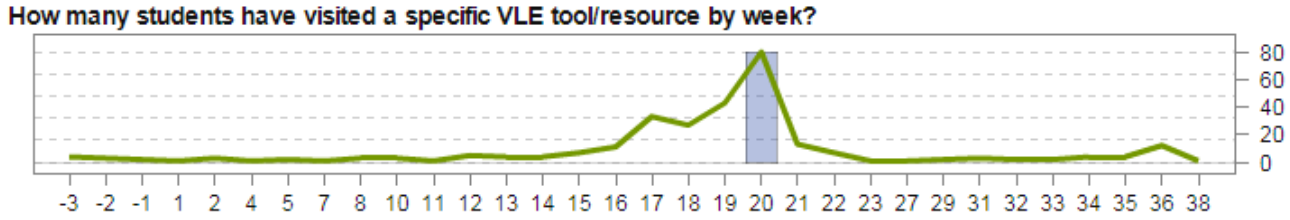

Figure 3 – Hamming codes - Online resource predominantly used in relation to assessment

The A4A data can help a module team make evidence-based decisions, with the ultimate goal of improving student experience on that module (Evans et al, 2017).

A limit to the usefulness of the A4A dashboard is that in its usual format it cannot identify online activity at an individual student level. In consultation with the analytics design team it was established that the underlying data could be presented at an individual student level if required, drilling down to explore the data in more depth.

The research was conducted in three main phases. During the first phase (2017 to July 2018) a pilot study was conducted which commenced with the collection of key analytics data via A4A on CALT resource use during the 2016/17 module presentation. From this the sub-set of students was identified for further research. In consultation with analytics team this data was interrogated more deeply. The second phase was designed to supplement the analytics data via semi-formal interview questions, to help address limitations such as those noted by Macfadyen and Dawson (2010). Interviews took place July 2018 and was followed by an initial review of findings. There were some technical difficulties with the recording of interviews so a change was made in the recoding method, from internal Skype to mobile phone recording. The third phase involved dissemination of findings.

Findings of the project

In reviewing the data relating to the TM355 students who answered the specific exam question relating to error coding, the small sample of 48 students was selected from the cohort of 329 students who sat the final examination. The data relating to their online activity with the related CALT resource was mapped alongside their examination score for the question, with results as follows:

- Average exam score overall for all students – 45%
- Not used error control codes CALT resource at all – 30%
- Used error control codes CALT during the module, at least once – 53%
- Used error control codes CALT specifically at revision May/June – 52%
- Used error control codes CALT on more than one specific date – 58 %

This snapshot relating to student performance suggests that those who engaged fully with the CALT resource did relatively well, although care should be taken to avoid confusion over correlation and causation (Ferguson and Clow, 2017).

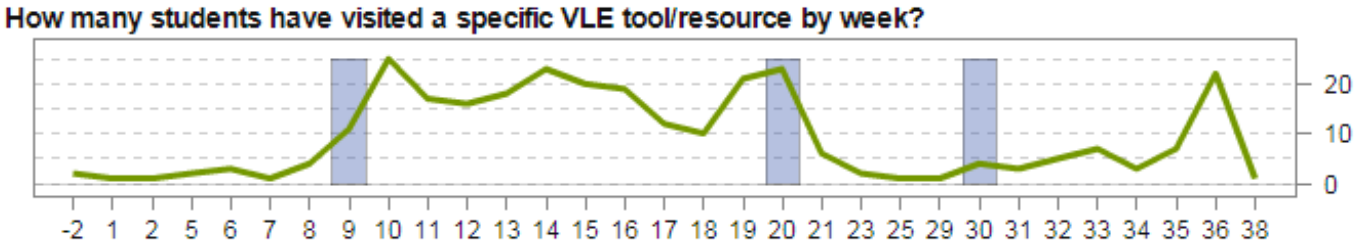

Figure 4 – Error control codes - Online resource used at specific times during a module

From Figure 4 it can be seen that between weeks 9 and 20 about 200 students used the CALT resource relating to error control codes. Some of these might be students who used the resource more than once, so they are double counted in that figure of 200. Even so, although the use of the resource might be seen as disappointing, it would be reasonable to suppose that at least half the students used it in this period. That is also consistent with the 53% usage figure for students who attempted the examination question relating to error control codes. However, far fewer than half of the student cohort felt confident to do the exam question. If students distributed themselves evenly across the three optional exam questions, we could expect 66% of them to attempt the question. It is reasonable to suppose that by the time the students sat the examination they had not used the online resource for several months, unless they also used it in the revision period. From the A4A data it is possible to can see that very few students used it then. It is therefore reasonable to hypothesise that students should be reminded of the importance of including the CALT resources in their revision. Engagement with the online materials should be encouraged, as they should enhance the learning experience by exposing students to a wider variety of learning techniques.

To help offset the limitations of small-scale research, the results for the focus sample in this study were compared with the wider cohort by reviewing student achievement relating to their cumulative Open University study on previous modules, as summarised in Figure 5.

Summary Statistics

Results

The MEANS Procedure

Analysis Variable : P_target_result1 Probability of student passing the module							
original_sample	N Obs	Mean	Std Dev	Minimum	Maximum	Mode	N
0	271	0.8670889	0.1349558	0.2279104	0.9876422	0.5742115	271
1	48	0.8516501	0.1430410	0.1702492	0.9850042	0.5742115	48

Figure 5 – statistical analysis of sample

To accomplish this, the student records for the focus sample were compared to all other student records from the cohort. The data set was coded as sample=1 for those who answered the particular exam question referred to in this study, and the others flagged sample = 0, so differentiating between the groups. The column p_target_result1 is the predicted probabilities of success for the students at module start. A comparison of the mean predictive probability in each group shows they are very similar although the sample group of 48 students is marginally weaker, as highlighted above. This suggests that even though the sample size is small there is no reason to assume that the sample group should perform any differently to the rest of the cohort.

Key stakeholders have been informed of project outputs. For examples, ALs on TM355 were provided with a summary of findings, and asked to promote the CALT, resources. Students were also given further advice on how beneficial the CALT resources are in supporting studies. Other module teams can find details of the project and its findings via ORO (2021).

Impact of the research

The findings from this study suggest that there are several actions that could be taken, for example:

- Give a clearer indication of time needed for the CALT activities (although obviously this will vary for each student).
- Add short descriptions about what kind of activity it is, for example interactive, video.
- Promote the activities in a new module introductory or revision video or podcast.
- Use the module forums to promote them
- Have 'talking heads' of students saying how useful they were.
- Add further detail to the introduction to certain activities, for example to explain the orientation in the 'launching a wave' activity.

Several of these ideas suggested via the interviews have already been implemented and others could be actioned in the future. For example. Figure 6 depicts a section of a resource that has been produced to give students an overview of the activity type and typical timings, alongside a direct link to the activity and an indication on where it fits in the student study calendar.

Block	Part	Week	Online Activity	Activity Name and module link	Short Description	Estimated Time Req.
1	1	1-3	1.1	Fourier Transforms	Interactive activity showing time-domain representation and frequency-domain representation for sine, square, sawtooth and triangular waveforms.	15-30 mins

Figure 6 – TM355 CALT resource description and timing example

Also, a new revision podcast has been produced which specifically promotes the use of the CALT resource at revision time, hopefully resulting in more students revisiting the online resources. TM355 has a good retention rate, but there is always room for improvement. The research suggest that the CALT resources can be beneficial for students to use throughout their study of TM355.

List of deliverables

Journal paper:

ORO (2020). Analytics for Tracking Student Engagement. Journal of Interactive Media in Education, 2020(1), article no. 22.

Conference paper:

ORO (2021) Analytics for tracking student engagement. In: *Blended and online education within European university networks*. The Online, Open and Flexible Higher Education Conference 2019 - Proceedings. (Ubachs, George and Joosten-Adriaanse, Fenna eds.) pp. 15–2

Conference presentaions and posters:

eSTEeM conference presentation (April 2018)
Poster presentation at CARLG (June 2018)
eSTEeM conference presentation (April 2019)
eSTEeM final report (2021)

References

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Tempelaar, D., Rienties, B. and Nguyen, Q. (2017). Towards actionable learning analytics using dispositions. IEEE Transactions on Learning Technologies, 10(1) pp. 6–16.

University approval processes

The research was approved by the Open University's Research Ethics Committee and has been logged as GPDR compliant.

- SRPP/SSPP – Approval from the Student Research Project Panel/Staff Survey Project Panel was obtained according to the Open University's code of practice and procedures before embarking on this project. Application number 2019/075
- Ethical review – HREC checklist completed.
- Data Protection Impact Assessment/Compliance Check – A Data Protection Impact Assessment/Compliance Check was obtained according to the Open University's code of practice and procedures before embarking on this project. Having gone through the DPIA screening questions this was not required.
- IAR –reference number is: 28 04 010

Appendix A – Email invitation to student to take part.

Dear TM355 Student

I am writing to you because you recently studied TM355 and I hope you will be willing to answer a few telephone interview questions about a particular aspect of your study, namely the use of the online computer aided learning (CAL) tools that support the written texts. Your responses will help the TM355 module team to improve students' experience on the module, and your input to the project would be greatly appreciated.

The main aims of the interview are to discover to what extent the online CAL tools support your TM355 studies and to get an insight into how you use the CAL tools. All responses are valued, even if you did not use the CAL tools to any great extent, or not at all. The interview consists of 12 questions, which should take about 30 minutes to answer. The interview will be via telephone and recorded, and responses will be completely anonymous.

Your experience is very important: any information you can give will help to inform the module team about improvements we could make to enhance the online aspects of the module, so I hope very much you will agree to take part. If so please complete the consent form and email it back.

Best wishes,

Christine Gardner (c.f.gardner@open.ac.uk, TM355 module team).

Reminder email
(To be sent to students approximately 2 ½ weeks after the initial email)

Dear Student

A couple of weeks ago, I wrote to you inviting you to take part in a telephone interview about your learning experience on TM355.

My sincere thanks to you if you have already responded. If you haven't yet responded and would be willing to take part, this is just to remind you that the invitation is still open until xxx and to reiterate **how important your answers are.** If you would like to participate please complete the consent form and email it back.

Best wishes,

Christine Gardner (c.f.gardner@open.ac.uk, TM355 module team)

Interview preamble:

Thank you for your willingness to take part in this project. Your responses will help us better understand your experience on TM355. There are 12 questions and the interview is likely to take about 30 minutes to complete. The interviews are scheduled for August/September 2019, so we will contact you very soon to arrange a suitable time and date.

During the interview the main aim is to discover to what extent the online CAL (computer aided learning) tools support your study. Please respond to each question as frankly as possible. If there are any questions you would rather not respond to, there is no need to provide an answer. Your interview responses will be completely anonymous.

Best wishes,

Christine Gardner (c.f.gardner@open.ac.uk, TM355 module team)

Appendix B - Student Consent Form

If you are willing to take part in this research project please tick the box, complete the details below and return the signed form.

The telephone interviews will be recorded and at any time during the research you are free to withdraw and to request the destruction of any data that have been gathered from you, up to the point at which data are aggregated for analysis.

Your participation or non-participation will not affect your access to tutorial support or the results of your assessments.

The results of any research project involving Open University students constitute personal data under the Data Protection Act. Any personal data (names and, email addresses, consent form for interviews) will be collected, processed and stored in accordance with data protection and GDPR legislation and our Student Privacy Policy http://www.open.ac.uk/students/charter/essential-documents/student-privacy-notice. They will be kept secure and not released to any third party.

Raw data will be destroyed at the end of the project, which is set to be at the end of 2019.

☐ *I am willing to take part in this research, and I give my permission for the data collected to be used in an anonymous form in any written reports, presentations and published papers relating to this study. My written consent will be sought separately before any identifiable data are used in such dissemination.*

Please provide your contact details below so that we can arrange a time and date for this interview (scheduled for August/September 2019):

Name: _____

Student PI: _____

Contact Telephone No: _____

Contact Email Address: _____

Signing this form indicates that you understand the purpose of the research, as explained in the covering letter, and accept the conditions for handling the data you provide.

Signature: _____

Date of Signature: _____

Appendix C - Covering letter

This research is being undertaken as part of an Open University eSTEeM project. Details of eSTEeM can be found at http://www.open.ac.uk/about/teaching-and-learning/esteem/

The title of the project is "Analytics for tracking student engagement" and the main aim is to find out more about TM355 students' use of online computer aided learning (CAL) tools. The module team would like to discover to what extent the online CAL tools support students' TM355 studies and also get a clearer insight into how students use the CAL tools.

For the research, a number of students will be invited to participate in semi-structured telephone interviews. The interview consists of up to 12 questions, which in total should take about 30 minutes to answer. All responses are valued, even if you are currently not using the CAL tools to any great extent, or not at all. It is not essential to answer all of the questions.

The interviews will be recorded and transcribed and both the recordings and transcriptions will be used during analysis. The interview responses will be completely anonymous.

The student consent form confirms your agreement to be involved in this research, and agreement with the proposed data recording and publication strategies.

Please return completed form to: c.f.gardner@open.ac.uk

Interview questions

The following are the key questions for the interview (semi-structured):

1. When studying TM355 have you used the associated CAL (computer aided learning) activities?
2. If no, why not?
3. If yes, ask if the CAL activities were used in sequence, i.e. at the time specified in the study guide.
4. Did you try all of the CAL activities? Was it none, some , most, all?
5. Were some of the CAL activities more useful than others for reinforcing key module concepts? If so, which ones and why. [Here provide a list of the CAL resources].
6. Do you plan to revisit the CAL activities at revision time?
7. Would you recommend any specific CAL activities to other TM355 students?
8. If no, why?
9. If yes what were the most helpful aspect/s?
10. What device/devices did you use to access the CAL tools ?
11. Did you search for/find any non-OU resources for any TM355 topics (and if so which ones)?
12. Is there anything else you would like to add?