Using Power Tools to Automate and Scale Personalized Feedback to Learners

Ikechukwu Ogbuchi, Atlantic Technological University, Ireland
Etain Kiely, Atlantic Technological University, Ireland
Cormac Quigley, Atlantic Technological University, Ireland
Donal McGinty, Atlantic Technological University, Ireland
Konrad Mulrennan, Atlantic Technological University, Ireland
John Donovan, Atlantic Technological University, Ireland

Abstract
A critical strategy of motivating students and improving performance in higher education is communicating timely and personalized feedback (Koenka et al., 2019). The language used to deliver students' progress and what specific intervention can support their learning is hugely impactful especially for students who are struggling. This can also be challenging for the academic community to implement when lecturing to large cohorts of year 1 students. This paper presents how the learning analytics team in ATU Galway have developed a data pipeline to ensure students receive appropriate and personalized feedback on their progress in year 1 Science and Computing modules. This work initially began with the DANIEL project in 2015 which employed a semi-automated process and has evolved to a streamlined automated process embedding the tools of the MS Power environment. This research output is the result of a close collaboration with academics, researchers and the Computing Services team transforming Moodle data into meaningful information and insights for students. The step-by step process of how this is achieved using Power Apps (lecturer interface for feedback and progress thresholds), Power Automate to trigger large scale communication, Power BI (visualization of cohorts' performance). Learners have engaged as partners in the development at each phase of the process and their experiences of this transformed digital learning feedback systems are explored.

Keywords: Data Analysis, Students, Automate, Power Bi, Feedback, Personalized, Education

iafor

The International Academic Forum
www.iafor.org

Introduction

Feedback on assessment and course deliverables to students has been shown to be vital in their success (Faulconer et al., 2022). Research shows that effective feedback does not benefit only the students but provides constructive feedback for the teachers or lecturers as well (Obilor, 2019). Students learn more effectively when they receive clear guidance on how they can improve (Mag, 2019) and they also have diverse needs, which makes it important that feedback systems are designed to meet these diverse and personalised learning needs (Henderson et al., 2021).

There have been limitations and challenges with giving face to face feedback considering the time commitment and volume of students who need this, technology assisted feedback has gained a lot of momentum in recent years (Lopes et al., 2018). The challenges presented by Covid in 2020 created opportunity when educators were required to adopt virtual learning tools as new modalities for providing feedback to students (Carby, 2023).

However, creating feedback virtually presents different challenges, which include high workload associated with providing this feedback regularly to numerous students (Paris, 2022) and time constraints associated with disseminating personalized feedback (Michael et al., 2019). The challenges with dissemination of feedback have spurred on an interest in experimenting with latest technologies like the Microsoft Power Tools to discover how best technology can be leveraged to mitigate these challenges while providing useful personalized feedback at scale to students. This renewed interest has motivated our research. The research team are also motivated to uncover the reasons for low engagement and subsequent dropout in higher education especially in computing modules (O'Brien, C. 2022).

Methodology

In developing a data pipeline for personalized and appropriate feedback using power tools, relevant learner data is collected and processed and cleaned to be suitable for learner feedback format. Data that has been used for this study was extracted from the virtual learning environment Moodle.   Eight columns were selected for building the automated system pipeline which are presented in Table 1.

Column	Description	Data Type
Average Grade	Grade scored for the math module.	Numeric values.
Interactions	Interactions count from log files based on Moodle interactions.	Numeric value.
Journal Score	Score of student participation in journal classes (designed to encourage students work together and practice topics under guidance).	Numeric value
Quiz Scores	Score of students during their quizzes.	Numeric values.
Journal Attendance	Gives a percentage of student journal attendance rate.	Numeric Value.
Lecture Attendance	Gives students general lecture attendance rate. .	Numeric value
Name	Student name for identification and personalization.	String Value.
Email Address	Student's email, unique identifier to the student registration numbers for sending personalized emails.	String values.

Table 1: Moodle data columns used for personalised feedback

Two methods were employed based on the data we have:

Method One: Jupyter and Power Automate Pipeline

The following are steps followed using this method:

Data Cleaning & Preparation: At this phase data is cleaned and formatted for analysis to avoid errors. This is achieved by replacing missing values with a specific value or getting rid of it altogether. Data extracted from Moodle is loaded into a Jupyter Notebook environment where Python code is activated to automatically clean the imported data.

- **Comment Generation:** Once the data is cleansed and formatted, another Python script is activated to loop through the selected columns and output new columns that contain unique comments for the students based on values the script identifies in the columns. Python conditional statement is used here to assign different comments to different column score values. The code presented in figure 1 illustrates how a student with a low score are encouraged and offered further support.

```python
for i in range(data.shape[0]):
    #Journal
    if data['Journal_score'][i]>=4.5:
        data.loc[i,('journalcomment')]+="Your Total Journal score was way above the average. Way to go! Keep it up."
    elif data['Journal_score'][i]>=2.5:
        data.loc[i,('journalcomment')]+="Your Total Journal score was above average.
        "Good one, keep trying hard to complete all journals."
    elif data['Journal_score'][i]<2.5:
        data.loc[i,('journalcomment')]+="Your Total Journal performance was below average.
        "..We know that maths could be challenging, but we believe that with consistent and frequent work you can
        "..achieve better outcomes."

    #Quiz
    if data['Quiz_score'][i]>4:
        data.loc[i,('quizcomment')]+="You performed well above average on your Quizzes. You should be happy! Keep it up"
    elif data['Quiz_score'][i]>=2.5:
        data.loc[i,('quizcomment')]+="You performed above the average score for your quizzes,however mastery requires
        ".. repetition until can't get it wrong."
    elif data['Quiz_score'][i]<2.5:
        data.loc[i,('quizcomment')]+="Your performance on the Quizzes was below average. We believe you can achieve maste
        "..if you try to put in more effort, we can support you."

    #Attendance
    if data['Lecture_attendance'][i]>=70:
        data.loc[i,('attendancecomment')]+="Your attendance rate has been great this semester. Keep it up"
    elif data['Lecture_attendance'][i]<70:
        data.loc[i,('attendancecomment')]+="You need to attend your classes often to improve your attendance score"

    #Interactions
    if data['interactions'][i]>=690:
        data.loc[i,('interactioncomment')]+="Our systems show you are interacting very well with Moodle.
        "That is a good habit. Keep it up"
    elif data['interactions'][i]>200:
        data.loc[i,('interactioncomment')]+="Our systems show your level of interaction with moodle is below average.
            "Evidence shows that students who interact frequently with the online materials perform well in the module."

    elif data['interactions'][i]<=200:
        data.loc[i,('interactioncomment')]+="Our systems show you have not been interacting with moodle that much.
        "We hope everything is okay? Let us know how we can help you through the feedback form"
```

Figure 1: Comment Generation using Python Script

- **Secure Data Transfer through API:** As soon as the script for comment generation is run and complete in the Jupyter/Python environment, then all the newly generated data is securely transferred to the Microsoft Power environment where the power tools of flow can be applied to send unique feedback to students.

A new flow was created in Power automate. A simple flow that simply receives a HTTP request and sends an email is created as shown in Figure 2.
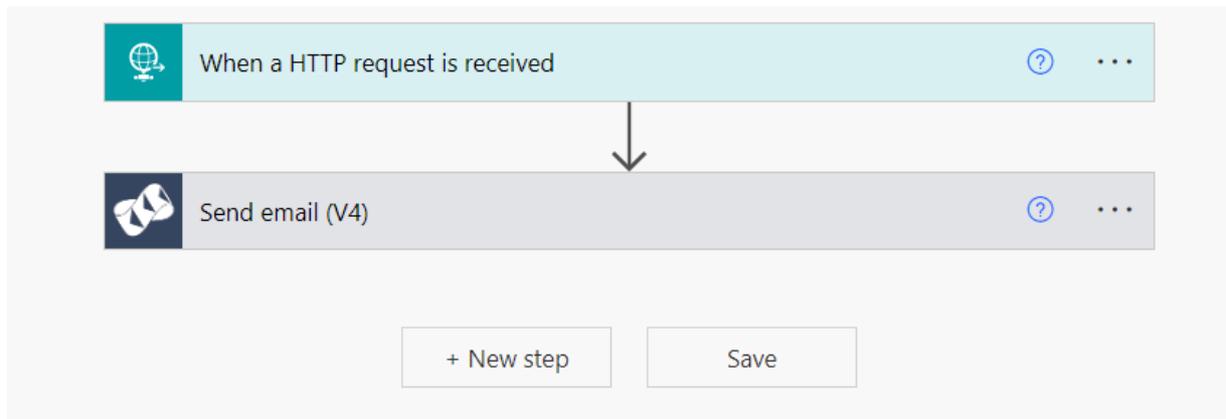
Figure 2: Power Automate Flow Steps

Data from the Jupyter environment is pointed to the URL generated by the "when a HTTP request is received" step of the above flow. Data is sent from the python environment using the requests package in a script as presented in Figure 3.

```python
import requests
count=0
url='
for i in result_loads:
    headers = {'Content-type': 'application/json', 'Accept': 'text/plain'}
    r = requests.post(url, data=json.dumps(i), headers=headers)
    print(r)
    count+=1
print(str(count) + ' emails sent out via script.')
```
Figure 3: Connecting Data through API from Jupyter Environment

The URL link from Microsoft Flow created must be in the space in red for the data to move correctly and a description of the data schema coming through the API was made in the Power Automate environment. A successful connection leads us to the next stage in Pipeline which is Email design/dispatch.

- **Email Design/Dispatch:** Before the email is sent through activation of Python script, an email template is created in the Power Automate environment. All data coming through are held in variable names, this includes the unique comments for each student based on their performance earlier generated in the Jupyter/Python environment.
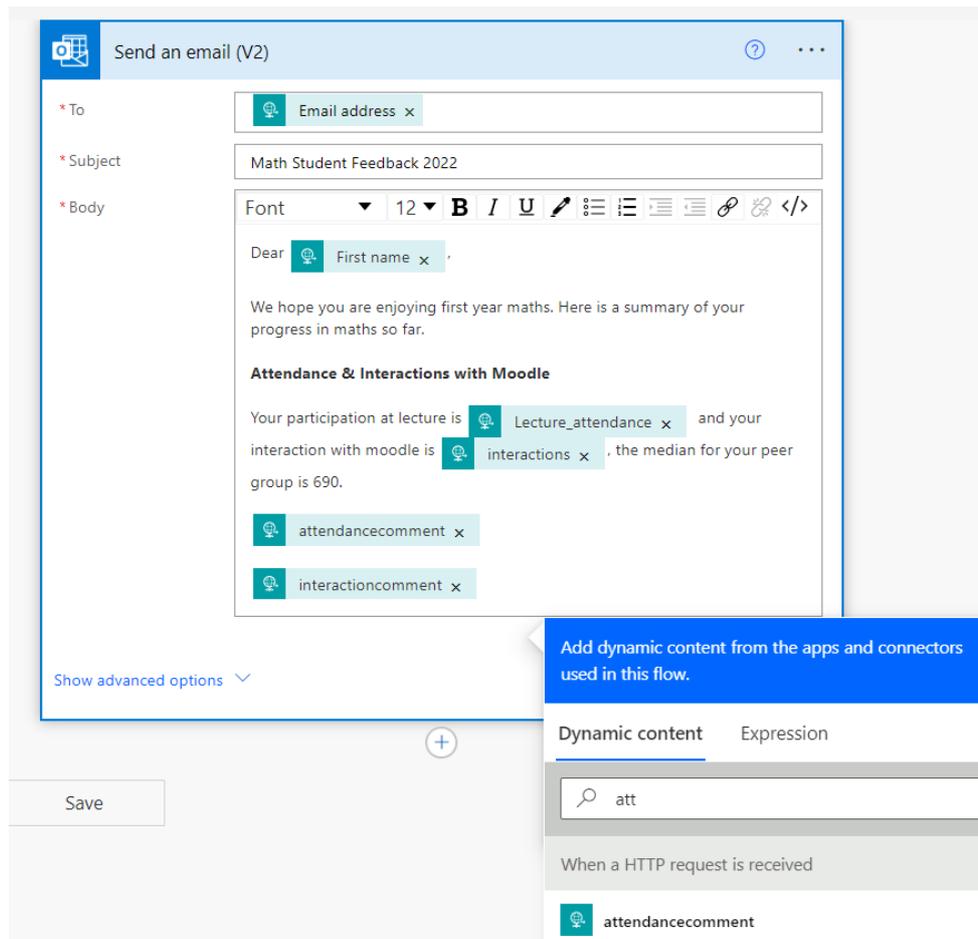
A template is presented in Figure 4.

Figure 4: Email Template design

The dynamic content from the schema set in the first flow step is generated from the template. Additional edits can be made here to for the email edited to the correct format for the lecturer's preference.

Once it is satisfactory, the email is dispatched by activating the python script through the terminal and the email template is sent out with unique comments coming through for every student, personalized to their performance but taking this general template structure.

A sample email sent is shown in Figure 5.

Maths 1.1 Personalised Feedback Form

Group

Dear *student*

We hope you are enjoying first year maths. Here is a summary of your progress in maths so far.

Journal Work *(20%)* (out of 5%)	Quizzes *(15%)* (out of 4.5%)	Exams *(65%)* Week 7 (out of 10%)	Marks so far (out of 19.5%)	Average Mark so far %
3.3%	1.5%	7.0%	11.8%	60.7%

Remember there is no such thing as a maths gene. All our brains have a remarkable capacity to grow and change and with **frequent practice and effort.**

Lecture Class Participation

Your participation at lectures **100.0.%**

You are attending most of your lectures, good effort.

Journal Work (Mandatory Attendance)

Your participation in journals **is 100.0%**

Great effort on attending all your journal classes.

Your mark for Journal 1 and 2 is averaging at **66.7%.** Because your journal mark is weighted by attendance your mark becomes **66.7%.** This effort contributes towards **3.3**% out of 5% available so far for journal work.

Moodle Quiz Effort

Of the **3 semester 1 quizzes so far,** you have achieved 100%, **mastery** in 1.0. This equates to **1.5%** of the 4.5% available for quizzes. *You have achieved a 10/10 well done on trying. Keep going until you achieve 10 on all quizzes, they are a great way of learning through retrieval and practice and build strong neural pathways.*

Only the **quizzes that you get 100%** in will **contribute towards your final mark.** When we make a mistake, synapses fire in your brain which means learning occurs. Quizzes are a great opportunity to practice and learn from your mistakes and are used again in exam questions.

Week 7 Exam

You achieved **70.0**% the week 7 exam. This contributes to **7.0**% of overall marks in maths.

Please free to ask questions in lectures or in journal classes.

Figure 5: Sample Email sent using Method one

Method Two: Jupyter /PowerApps Pipeline

This method uses PowerApps to achieve the outcomes of method 1 within an end-to-end application that can easily be used by academic staff.

This method explores the use of PowerApps platform combined with cleaned data from Jupyter notebook for the same purpose. The PowerApps platform enables anyone create custom apps.

This would allow more flexibility for educators to set their own thresholds or edit the personalized comments they want to make without having to worry about all the computational processes.

This idea was tested on a small sample dataset with three columns "Email, name and score". The steps taken were as follows:

Data Cleaning and Preparation: Here the demo data used was formatted using Jupyter notebook to the Power App. The advantage of the PowerApps over the previous method is that it is a lot easier to directly connect a dataset to the Power App.

Comment Generation: The comment generation using PowerApps is different as it achieved in the Power environment rather than within Jupyter notebook. A simple click of a button in the PowerApps after relevant scores and comments have been added to the app enables an academic staff member set thresholds and comment fields. Some of these comments are prepopulated based on best practice in student feedback as illustrated in Figure 6
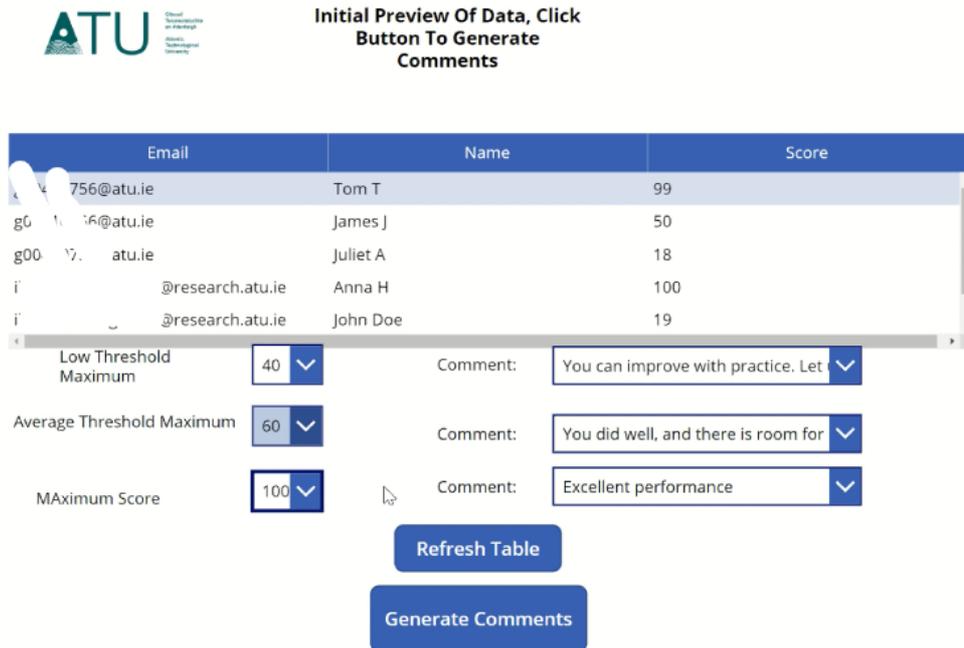

Figure 6: Power Apps initial screen

Once the generate comments button is clicked, the application proceeds to the next screen where a preview of the new column added to the table is generated as shown in Figure 7.
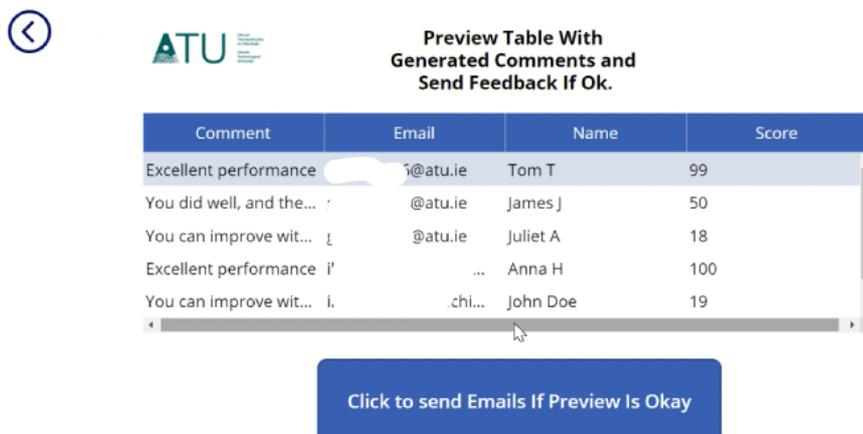

Figure 7: Power Apps Comment Generation Preview Screen

This leads on the next step.

Email Design/Email Dispatch:

The email design for this method is similar to method 1 as the "Click to send Emails if Preview is Okay" button shown in Figure 7 above triggers a Power Automate flow designed as presented in Figure 8.
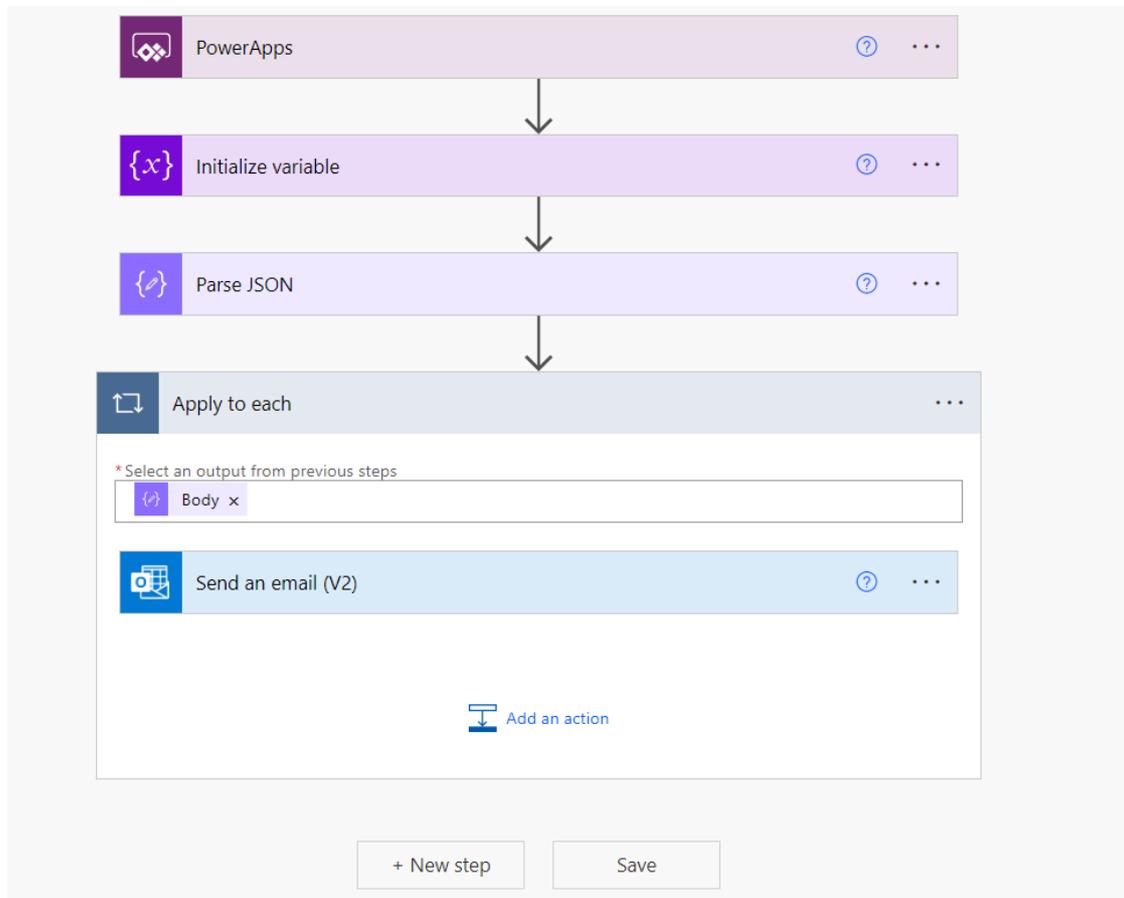

Figure 8: Power Automate Flow connection from PowerApps.

In the flow steps, data with comment generated from app is handled using the initialize variable step. Variables are used for storing and managing data from PowerApps. However, because the initialized variable contains all the data from the table and personalized feedback is to be sent to each component of the stored variable, the Parse JSON step was used to break down the stored variable in specified structure presented in Figure 9:

```
'Parse JSON' (code view)

 1  {
 2      "inputs": {
 3          "content": "@variables('varCollection')",
 4          "schema": {
 5              "type": "array",
 6              "items": {
 7                  "type": "object",
 8                  "properties": {
 9                      "Comment": {
10                          "type": "string"
11                      },
12                      "Email": {
13                          "type": "string"
14                      },
15                      "Name": {
16                          "type": "string"
17                      },
18                      "Score": {
19                          "type": "number"
20                      }
21                  },
```

Done

Figure 9: Parse JSON step for PowerApps button

This defines the properties of initialized variable data and enables data to be broken down into individual observations.

The next step in the flow process now sends an email to each observation from the parsed JSON step and email template for this testing purpose is shown in Figure 10.
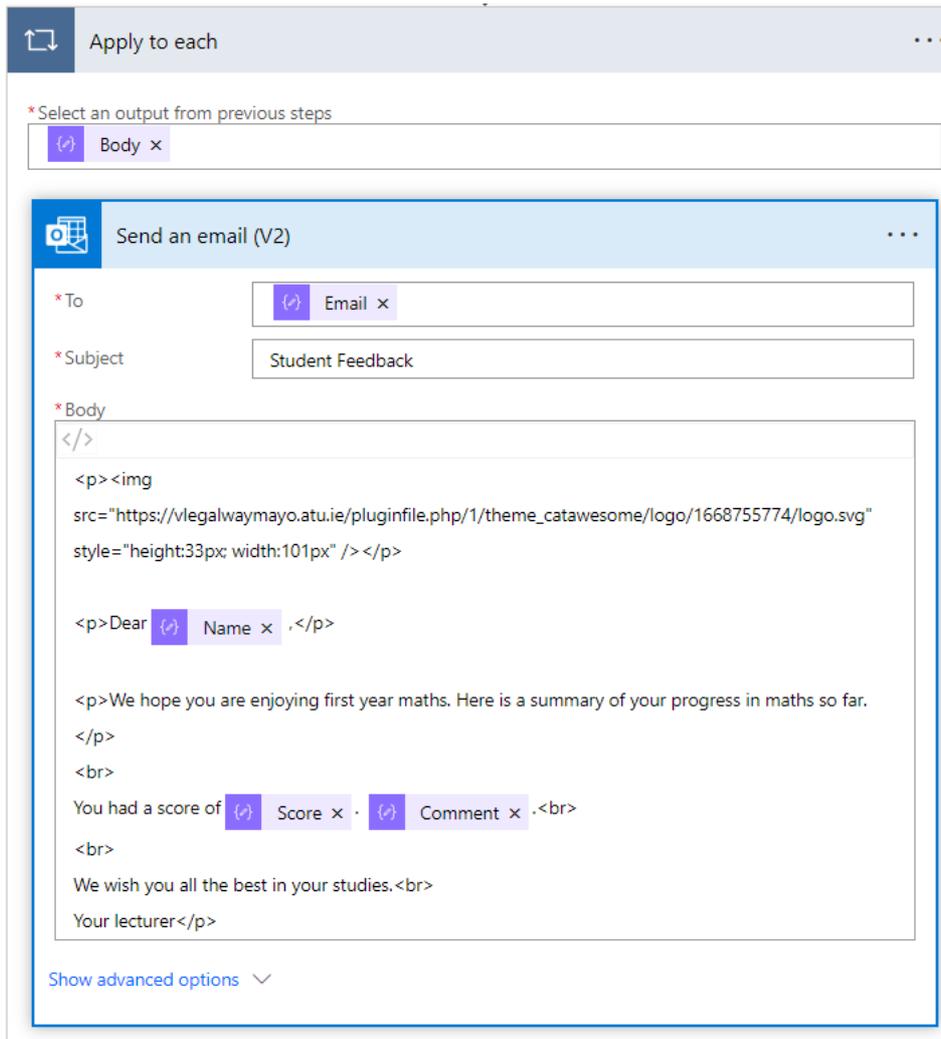
Figure 10: Email template for method two

Once the template is completed, the button configuration is saved and on clicking the button from Power Apps, the following screen appears as illustrated in Figure 11 confirming to the academic staff member confirming that the personalized feedback emails have been sent to the students.

Figure 11: End Screen on PowerApps

Sample test email sent out using the second method is shown below:

Dear John Doe ,

We hope you are enjoying first year maths. Here is a summary of your progress in maths so far.

You had a score of 19. We believe you can improve with practice.

We wish you all the best in your studies.
Your lecturer

Tá an ríomhphost seo faoi réir an tséanta seo leanas atá le fáil ag Séanadh Ríomhphost Ollscoil Teicneolaíochta an Atlantaigh
This e-mail is subject to the following disclaimer available at Atlantic TU Email Disclaimer

Figure 12: Sample test Email Sent out from pipeline two.

Results

We had earlier sent out to the feedback to 207 students who were consented partners in the research. To follow up students were asked for feedback on how they felt about the personalized feedback they received. Responses presented in Figure 13 showed that 93% of respondents found this feedback very useful.

93% rated between "**4 - 5**" for this question

Score distribution

Figure 13: Students' perceived usefulness of personalized emails

The majority of the students (82%) also preferred this mechanism to receive feedback. The word cloud in Figure 14 identifies email as the preferred communication tool. Students also valued in person communication.

Figure 14: Word Cloud showing feedback method preference.

There were some interesting comments from qualitative data coming through the students on feedback preference as shown in Figure 15:

144	_ _ _ _	By email, you can look at it in your own time and its less intimidating.
119	. . . . . . IY	I think the email is detailed enough for an objective topic like maths, but if we had more subjective assignments/exams like essays, I feel like in person feedback could be more constructive.

Figure 15: Random Student comments on feedback preference

Conclusion

This research highlights the potential of using power tools suite to automate and scale personalized feedback to learners. It also shows that leveraging technology to provide this feedback is welcomed by students who find it useful receiving feedback. This system also makes it a lot easier for educators to send customizable and personalized feedback to large student cohort in much shorter time than they would have used if they were to do it manually.

Acknowledgements

References

Carby, N. (2023). Personalized Feedback in a Virtual Learning Environment. Journal of Educational Supervision, 6(1). https://doi.org/10.31045/jes.6.1.3

Faulconer, E., Griffith, J., & Gruss, A. (2022). The impact of positive feedback on student outcomes and perceptions. *Assessment & Evaluation in Higher Education, 47*(2), 259-268. DOI:10.1080/02602938.2021.1910140

Henderson, M., Ryan, T., & Phillips, M. (2019). The challenges of feedback in higher education. Assessment & Evaluation in Higher Education, 44(8), 1237-1252. https://doi.org/10.1080/02602938.2019.1599815

Henderson, M., Ryan, T., Boud, D., Dawson, P., Phillips, M., Molloy, E., & Mahoney, P. (2021). The usefulness of feedback. Active Learning in Higher Education, 22(3), 229–243. https://doi.org/10.1177/1469787419872393

Koenka, A. C., & Anderman, E. M. (2019). Personalized feedback as a strategy for improving motivation and performance among middle school students. *Middle School Journal, 50*(5), 15-22. DOI:10.1080/00940771.2019.1674768

Lopes, A. P., Babo, M. L., Azevedo, J., & Torres, C. (2018). Rethinking Feedback in a Connected Age. In *INTED2018 Proceedings* (pp. 5273-5282).

Mag, A. (2019). The value of students' feedback. MATEC Web of Conferences, 290, 13006. https://doi.org/10.1051/matecconf/201929013006

Obilor, E. I. (2019). Feedback and Students' Learning. *International Journal of Innovative Research in Education, 7*, 40-47.

O'Brien, C. (2022). Student dropout rates climb across several universities amid concern over low engagement. The Irish Times. https://www.irishtimes.com/ireland/education/2022/05/28/student-dropout-rates-climb-across-many-universities-amid-concern-over-low-engagement/

Paris, B. M. (2022). Instructors' Perspectives of Challenges and Barriers to Providing Effective Feedback. Teaching & Learning Inquiry, 10. https://doi.org/10.20343/teachlearninqu.10.3

Contact emails: ikechukwu.nigel@yahoo.com
ikechukwu.ogbuchi@research.atu.ie