Google Forms: A Real-Time Formative Feedback Process for Adaptive Learning

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Abstract

In this paper, we describe our approach on how to achieve an adaptive learner-centric environment by using an unconventional student feedback process that utilizes Google Forms to periodically collect information about the course instruction. Students were asked to provide their input regarding lectures' clarity and content; the use of visual aids; time management; problem solving, instruction delivery; and student engagement in the classroom. Data collected from these anonymous surveys provided real-time formative feedback that helped faculty to react just in time to address issues related to student learning process. In addition to providing continuous feedback, this process has also shown to help students develop their metacognitive knowledge and therefore become more responsible towards their academic success. It also helped the instructor to understand the cognition profile of the student cohort to ultimately adapt the course content, pedagogy, and assessment to achieve an optimal learner-centric environment. The effectiveness of this approach was verified by assessing the students' performance in pre and post exams. The pre exam was conducted to assess the students' performance without the implementation of this approach while the post exam was conducted to assess the same students' performance after this approach was implemented. Assessment results revealed that the students subject to this study were able to improve their grades and score higher on a major exam than they previously did without the additional benefit of the periodical feedback. Instructional methods developed and incorporated into the course lectures for continuous improvement are also presented in this paper.

Introduction

In today's high emphasis on student achievements and success, engineering faculty have to constantly strive to create an effective learner-centric environment in their classrooms. To achieve this goal, faculty will not only have to attain excellence in teaching but also to establish a 2-way communication venue to adjust in time to any issues impeding the student learning process. Currently, the most common form of feedback that faculty receive in our institutions is the student course evaluation survey. However, these summative feedback surveys are usually conducted at the end of the semester, therefore have little if any useful impact on improving students' performance. Faculty have no time to adjust the instruction methodology or the learning activities resulting in static less effective learning environments. It is evident that there is an urging need for a formative feedback that can be used to adapt the learning process to the current cohort of students.

In a report published by the National Research Council in 2000, formative assessment/feedback and learner-centric environments were two out of the four tenets recommended for designing an effective classroom environment[1]. In a more recent report addressing the development of deeper learning published in 2012, the National Research Council also emphasized on the importance of the formative feedback in their recommendations[2]. In addition, the research community has been interested in formative feedback research since the late 80s and 90s[3,4]. However, the lack of the necessary technologies hindered the ability to implement a seamless formative feedback process.

Within the last decade, we have witnessed huge technological advancements which drove a large influx of research discussing formative feedback tools, their advantages, and the different methodologies to incorporate them within the learning process[5-16].

A complete feedback is a twofold process. The first process is the feedback for learning which comprise a continuous formative feedback procedure that focuses on improving the instruction and the content delivery to students. The second process is the feedback of learning which comprise a summative feedback survey conducted at the end of each semester to evaluate the efficacy of the instruction methodology, the content, and the student perspective of the overall learning experience. The latter process is already well institutionalized in almost all higher education institutions as an ABET requirement for continuous improvement. On the other hand, the real-time continuous formative feedback process is a great idea conceptually but it is rarely implemented since it is time consuming to collect student's feedback and conduct analysis for each course on a continuous basis. Therefore, we propose the use of Google Forms as a mean to systematically institutionalize the formative feedback process and continuously collect the students' feedback regarding their learning experience.

Google Forms and Google Apps Script

We propose to use Google Forms as a real-time formative feedback tool to collect students' feedback since it is a very simple, systematic, and easy to implement approach. Google Forms is an integrated web-based application that facilitates the design of online surveys, questionnaires, and quizzes with a user-friendly application programming interface (API) as illustrated in Figure 1.
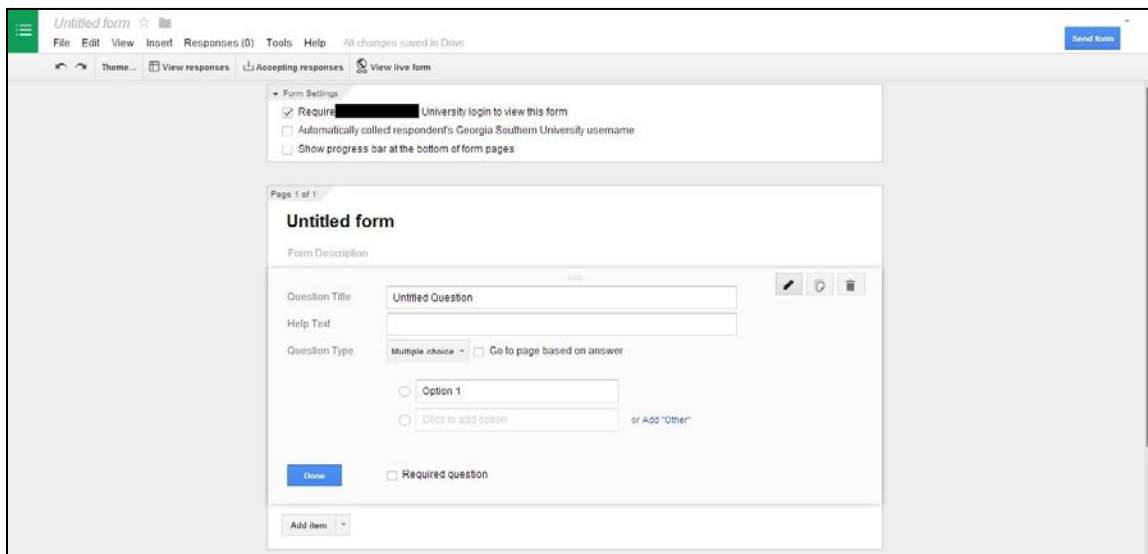

Figure 1- Google Forms Designer API

A Google Form is shared via email and all the collected responses are organized in a Google Spreadsheet stored in Google Drive. The benefits of using Google Forms over any other surveying software or online survey applications are as follows:

1. Google Forms has a modular structure which makes creating surveys as easy as adding questions and selecting options such as the type of question, the scale, and the labels. There is no need for Google Apps Script knowledge to add, delete, or modify questions. Figure 2 illustrates the process of designing a question in Google Forms.
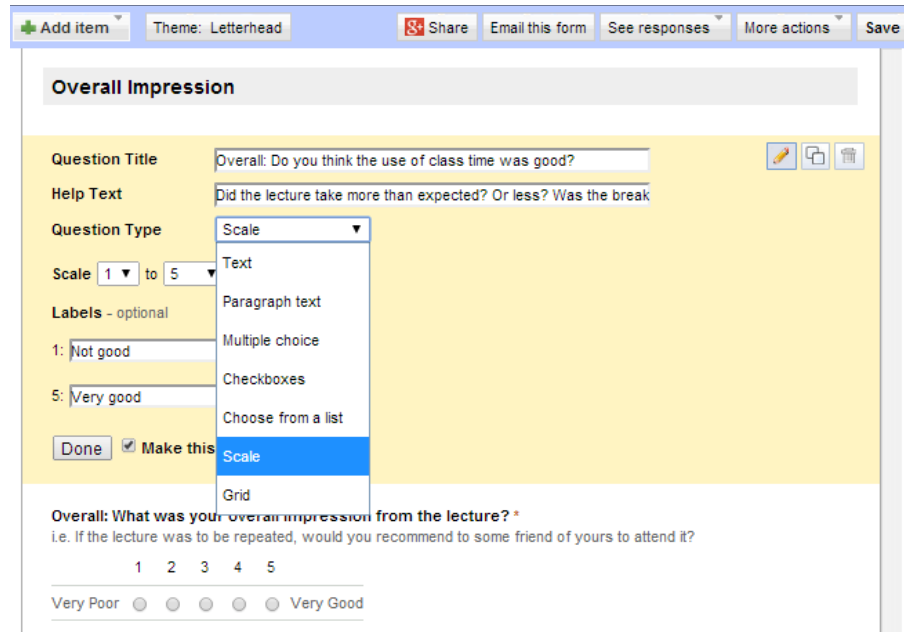

Figure 2- Designing Questions in Google Forms

2. Google Forms survey results are stored in a centralized Google Spreadsheet in your Google Drive. This facilitates the analysis process of large sets of data by using the predefined statistical functions and the charts within Google Spreadsheet. In addition, it allows the export of the survey data to Excel spreadsheet.

3. Google Forms does not limit the number of survey forms that can be created or the number of students that can participate in these surveys.

4. Google Forms allows email notifications whenever a response is submitted (Useful feature for time sensitive responses)

5. Google Forms supports a wide range of question types and options that are usually not supported in most online survey applications (Refer to Figure 2).

6. Google Forms provides the option of pre-populating fields, inserting images, and even embedding the survey within a webpage.

7. Google Forms supports logic branching which gives the option of customizing surveys on the fly based on the responses that each participant provides. Figure 3 illustrates how easy it is to use the logic branching option in Google Forms to customize the feedback survey based on a certain criteria (in this case we used the student major as an example). This is a unique feature that no other free online survey application supports.

Figure 3- Logic Branching in Google Forms

8. Google Forms support Google Apps Script, which is compared to Visual Basic based Macros in Microsoft Excel. Google Apps Script gives the user the ability to eliminate most of the manual processes and create automated dynamic Google Forms. Google Apps Script is basically a JavaScript running in the cloud using Google hardware. Google Apps Script allows the user to write small program scripts to open, create, edit, enhance the form design, and even react to submissions in an automated manner. Google Apps Script can help automate the process of creating, populating and sending forms. In addition, Google Apps Script can classify/categorize the responses and even plot the results. This feature isn't supported by any other online survey applications. An example of automating the creation of a form using Google Apps Script is illustrated in Figure 4.

Figure 4- Google Apps Script Example to Automatically Create a Google Form

These valuable features are what make Google Forms a viable real-time formative feedback tool compared to any other online survey applications.

The Formative Feedback Process

Using Google Forms as an electronic, web-based formative feedback process is a suitable alternative to the paper-based feedback process because it doesn't require class time, certainly less demanding to administer, and more convenient for students since they are not rushed to complete their feedback thus resulting in better responses. Since this process is assessing the student perspective of the teaching effectiveness, we used a standard set of questions across all the feedback surveys that we conducted to have a common basis for comparison in this study. However, we recommend the use of the logic branching to help customize the feedback process and make it more informative when it is implemented.

The frequency of conducting this survey was a challenging factor to optimize in order to prevent survey fatigue and maintain a good response rate. In one of our implementations, we used a very frequent model by conducting this survey once every lecture. We have noticed that within the first week (3 lectures) we were able to maintain a high response rate of 90%, however after the first week the response rate decreased exponentially to be around 10-20%. In another implementation, we used a less frequent model by conducting the survey only once a week coupled with a short quiz to assess the student technical competencies. In addition, we also provided an incentive to help maintain a good response rate. Our incentive was if the average response rate at the end of the semester for all the feedbacks is 75% or higher all the students will automatically get the 5% participation grade, and if not, this part of their grade will be assessed based on the usual criteria such as attendance and in-class participation. With this implementation, we were able to achieve an average response rate of 73%.

In this formative feedback process, the faculty has the option of modifying the survey and sending it manually or using the Google Apps Script to automate this process. In the following discussion, we will illustrate the case when the faculty automates the process. To automate the process, the faculty has to maintain a Google Spreadsheet with the roster email list and the topics covered within his/her course. At the end of every week, the faculty will run a Google Apps Script that will automatically populate the lecture topic drop-down menu in the Google Form template, send the form to all the students on the roster and finally mark this topic as sent to avoid any duplication. The topics addressed in the feedback are as follows:

- Content: Was the content interesting?
- Content: Was the focus of the talk good?
- Content: Did you find the lecture useful?
- Slides: Were they adequate in terms of the coverage of the subject?
- Slides: Were they readable and helpful for the lecture?
- Presentation: Was the lecture vocabulary understandable?
- Presentation: Was the speech (pronunciation, speed) of the lecturer clear?
- Interaction: Was the lecturer complete and precise in his answers to questions?
- Interaction: Did the lecturer manage to capture your attention?
- Overall: Do you think the use of class time was good?
- Overall: What was your overall impression from the lecture?

Figure 5 illustrates the Google Form template used in this formative feedback process.

EENG 5090 - Advanced Engineering Analysis

(Aim and General Notes)

This form aims to implement an adaptive feedback process to help me improve on my teaching style, content and the presentation of future subjects.

Feel free to be honest. This feedback is kept anonymous, the student names or IDs will not be tagged with your submission.

Thank you for the feedback.

* Required

Lecture Content

Content: Choose the lecture topic for which you are providing your feedback? *

ANOVA/Confidence Intervals/Mean Comparisons/Practice Example ▾

Content: Was the content interesting? *

Refers to everything presented and said within the lecture.

	1	2	3	4	5	
Very uninteresting	○	○	○	○	○	Very interesting

Content: Was the focus of the talk good? *

I.e. was the content of the lecture what you expected (related to the interest of the course).

	1	2	3	4	5	
Not at all	○	○	○	○	○	Definitely

Content: Did you find the lecture useful? *

This might mean that the lecture gave you the basis to look further, or that it had good references. It may also mean that it answered lots of questions, or that you consider the tools proposed worth a try. Usefulness can also come from the fact that you consider the knowledge gained applicable in your domain or line of work, or future work.

	1	2	3	4	5	
Not useful	○	○	○	○	○	Very Useful

Content: Additional Comments

i.e. Is there any unanswered questions? Is there any problems with the concepts discussed? Is there anything you like or dislike about the lecture? Any items need further review?

Lecture Slides

Slides: Were they adequate in terms of the coverage of the subject? *

In other words, do you think you found out the things you would expect?

	1	2	3	4	5	
Poor Coverage	○	○	○	○	○	Good Coverage

Slides: Were they readable and helpful for the lecture? *

If you could read it and you did not find the expression of ideas difficult to follow in the lecture, give a high grade.

	1	2	3	4	5	
Problematic	○	○	○	○	○	Helpful and supportive of the lecture

Slides: Additional Comments

Optional

Figure 5 (part 1/2)- Formative Feedback Google Form Template

Figure 5 (part 2/2)- Formative Feedback Google Form Template

The students receive an email with the Google Form attached in it as illustrated in Figure 6. They have until the beginning of the next week to anonymously respond to the Google Form. This will ensure the integrity of the process and will give students enough time to submit their responses without disturbing the learning process during the lectures.
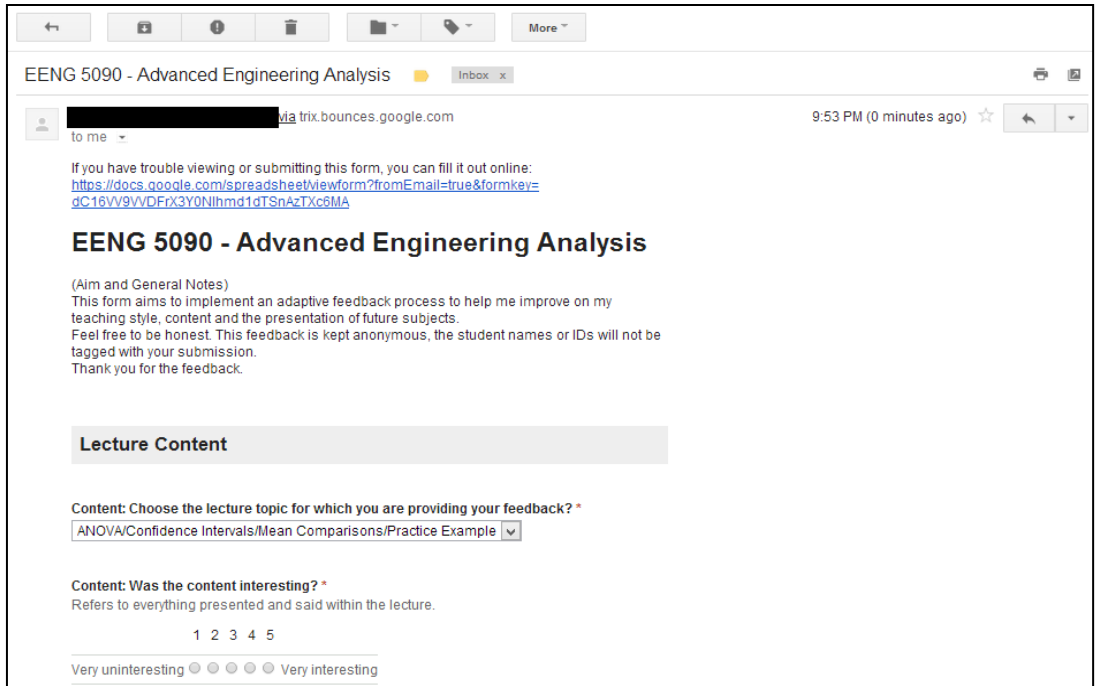
Figure 6- Email Sent to Students with the Google Forms

After submission of the responses, the faculty will have a Google Spreadsheet populated with all the responses. Figure 7 provides an example of some of the students' responses received.


Figure 7- Sample of the Submitted Students' Responses

Implementation and Evaluation

The proposed feedback process discussed in the previous section was implemented and the implementation of this feedback process helped faculty to adapt the learning process to achieve a learner-centric environment. This is evident from the feedback results obtained throughout the semester. A sampled timeline of the feedback results is illustrated in Figure 8. Figure 8 demonstrates the significant improvement in the students' overall satisfaction with the learning process achieved through the learner-centric environment. The improvement in feedback of the student perspective of the teaching effectiveness is mainly due to the pedagogy improvements that we implemented based on the feedback received from the students. The following analysis will assist in understanding the process to achieve a learner-centric environment.

The results of the content questions' showed an improvement as of the first feedback, indicating the effect of adapting the pedagogy. The pedagogy adaptation involved the addition of more practical application to the abstract theories which helped make the content more appealing for the students. As for the slides questions, students were mainly concerned about the lack of detailed theorem derivations. Therefore, the faculty added the detailed theorem derivations to the slides. This modification triggered a more serious concern regarding the ability to understand the derivations without actually carrying out the details step-by-step. This explains why the results dropped slightly in the median feedback. To address this shortcoming, the instructor switched the discussion of theorem derivations from using the slides to using the board and added an interactive problem solving component afterwards. The modification proved to have significantly helped the students capture the concepts more clearly. As for the presentation, the students brought up two main concerns. The first is that the jargon used was somehow difficult to understand and the second is a concern about the fast pace of the content presentation. To address these concerns, the definitions for new jargon were given before the discussion of new concepts. In addition, the pace of lecturing was toned down to give students more time to digest the material. This was achieved by adding more interactive problem solving discussions. Eventually, the instructor was able to address most of the students' questions and capture their attention since the time of continuous lecturing intervals never exceeded 10 minutes.
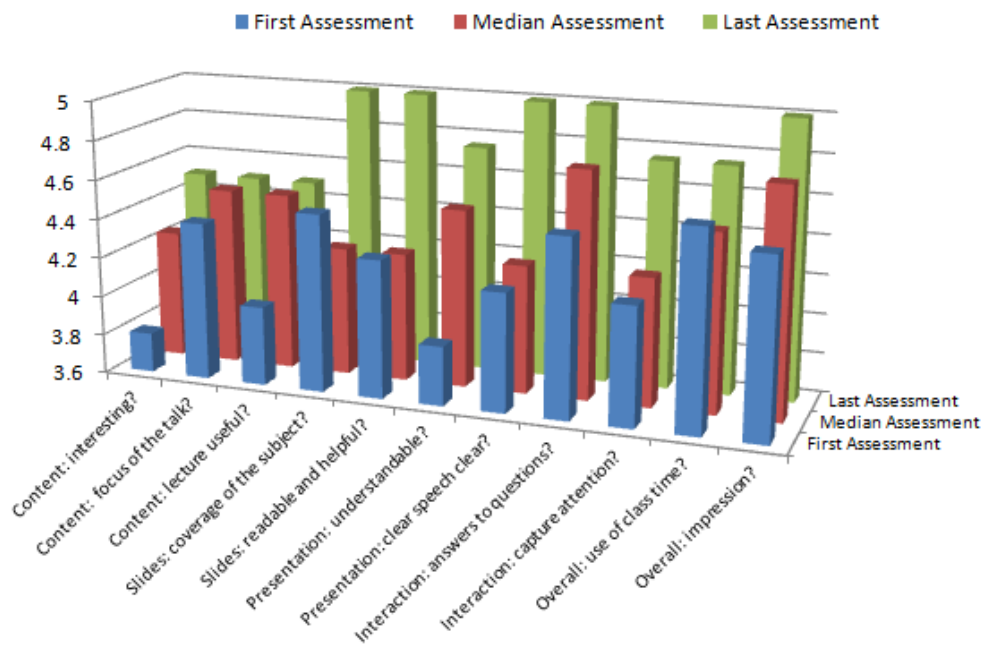
Figure 8- Sampled Timeline of the Feedback Results Improvement

Furthermore, the impact of introducing this formative feedback process was indirectly quantified by assessing the improvement in the students' performance due to adapting the pedagogy based on the students' feedback responses. The undergraduate engineering students' performance was assessed using pre and post exams. Within the first month of instructing the course, we did not use any form of formative feedback and at the end of the month the students' performance was assessed using a pre exam. Following the pre exam, we implemented the proposed formative feedback process. Similarly after one month of implementing this formative feedback process, the students' performance was assessed using a post exam. We used the Advanced Engineering Analysis course to implement the proposed process and assess its effectiveness. There were a

total of 19 students who were involved in the pre and post exams. The majority of students were seniors while the rest were juniors. The pre-exam consisted of four questions addressing topics related to discrete probability distributions while the post-exam consisted of four questions addressing topics related to continuous probability distributions. The pre exam was conducted before using the proposed formative feedback process while the post exam was conducted after using the proposed formative feedback process. Figure 9 shows the normal distribution fit for the results of the pre and post exams.
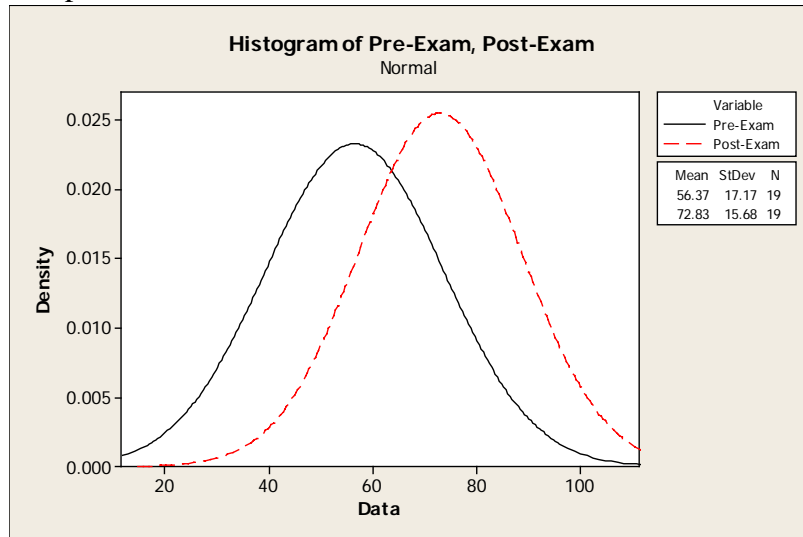
Figure 9- Fitting the Pre & Post Exam Grades into Normal Distributions

To statistically verify our findings, we conducted a thorough statistical analysis using the Minitab statistics software. Our null hypothesis stated that there were no statistical differences in the students grades obtained from the pre and post exams. To test this hypothesis, we used the General Linear Model to analyze our data with probability criterion for the significance level equal to 1% ($p=0.01$). This means that if the analysis generates a p-value less than the 0.01, then the null hypothesis can be rejected indicating that the pedagogy modification based on the formative feedback process is in fact useful. The response variable was the students' grades obtained in both exams. Figure 10 indicates that there are two main factors in this experiment.

Figure 10 – Main Effect Plot Illustrating the Effect of Students and Treatment

The first factor was the treatment effect modeled by the difference in the pre and post exam results. The second factor was the student effect modeled as a nuisance or blocking factor. The two-level tre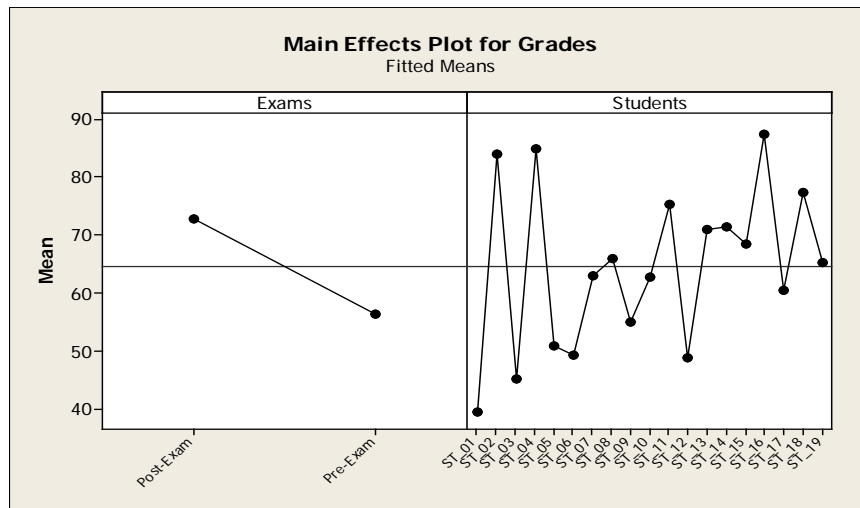atment was the effect of modifying the pedagogy based on the introduction of proposed formative feedback process on the students' overall achievement. We considered the differences among students as a blocking factor to eliminate their induced variability to the response variable. The analysis, as shown below, generated a p-value equal to **0.001** which is ten times smaller than the **0.01** criterion for significance. Therefore, we can reject the null hypothesis with a confidence level of **99.9%** and conclude that there is a statistically significant difference between the pre and the post exams which validates the effectiveness of the proposed process. To further investigate this conclusion, we conducted a Tukey's comparison with a confidence level of **99%**. The outcome of the Tukey's comparison also supported our conclusion that the results obtained from the pre and the post exams are statistically different due to modifying the pedagogy based on the students' feedback responses obtained by the formative feedback process.

Statistical Analysis Model (General Linear Model: Grades versus Exams, Students)

```
Factor      Type     Levels  Values
Exams       fixed        2   Post-Exam, Pre-Exam
Students    random      19   ST_01, ST_02, ST_03, ST_04, ST_05, ST_06, ST_07,
                             ST_08, ST_09, ST_10, ST_11, ST_12, ST_13, ST_14,
                             ST_15, ST_16, ST_17, ST_18, ST_19

Analysis of Variance for Grades, using Adjusted SS for Tests

Source     DF    Seq SS   Adj SS   Adj MS      F       P
Exams       1    2575.4   2575.4   2575.4   16.77   0.001
Students   18    6968.5   6968.5    387.1    2.52   0.029
Error      18    2763.9   2763.9    153.5
Total      37   12307.8

S = 12.3915   R-Sq = 77.54%   R-Sq(adj) = 53.84%

Grouping Information Using Tukey Method and 99.0% Confidence

Exams        N   Mean   Grouping
Post-Exam   19   72.83   A
Pre-Exam    19   56.37      B

Means that do not share a letter are significantly different.

Tukey 99.0% Simultaneous Confidence Intervals
Response Variable Grades
All Pairwise Comparisons among Levels of Exams
Exams = Post-Exam  subtracted from:

Exams       Lower   Center   Upper   -----+---------+---------+---------+-
Pre-Exam   -28.04  -16.46  -4.893   (-------------*--------------)
                                    -----+---------+---------+---------+-
                                       -24.0     -16.0     -8.0       0.0

Tukey Simultaneous Tests
Response Variable Grades
All Pairwise Comparisons among Levels of Exams
Exams = Post-Exam  subtracted from:

          Difference     SE of             Adjusted
Exams      of Means   Difference  T-Value   P-Value
Pre-Exam     -16.46        4.020   -4.095    0.0007
```

To test the model's goodness of fit, we conducted the analysis of the residual error in our response variable as shown in Figure 11. The results of the residual analysis shows that the residual error follows a Gaussian distribution which indicates that the model used was able to capture all the useful information.
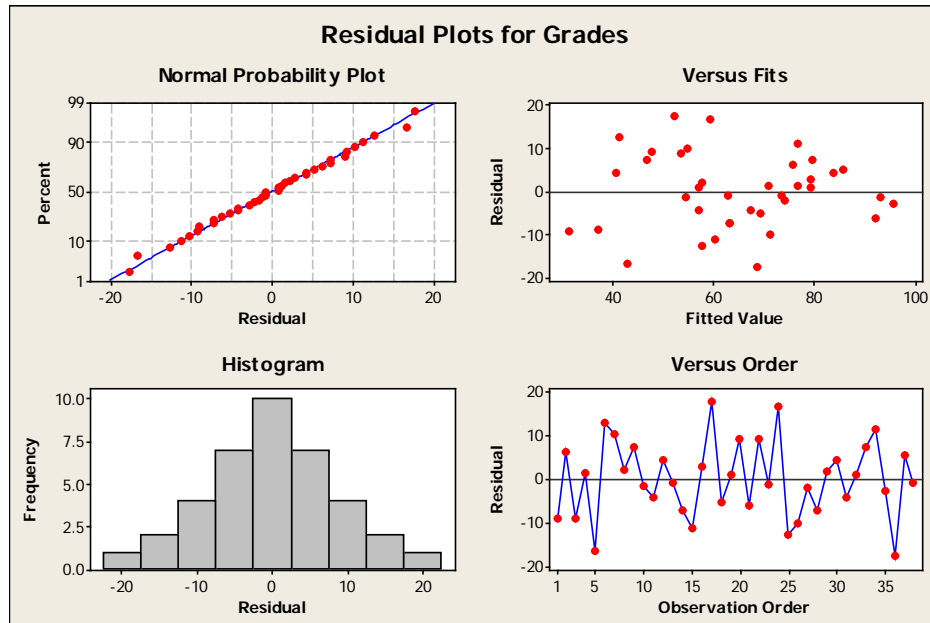

Figure 11- The Grades Residual Error Plots

Conclusions

Pedagogically, adaptive learner-centric classrooms are among the most current trends in education. The engaging nature of the adaptive learner-centric classroom helps students learn more efficiently and consequently improves the overall performance. To achieve a true adaptive learner-centric classroom, a continuous formative feedback process should be implemented. This paper presented a seamless implementation of a continuous formative feedback process using Google Forms as an automated feedback tool. Pre and post exams were conducted to measure the effectiveness of this process. We concluded that this approach is in fact effective, which was also inferred by the statistical analysis with 99.9% confidence level. In addition to providing constant feedback, these surveys have also contributed to help students develop their metacognitive knowledge and therefore become more responsible towards their academic success. It also helped the instructor to understand the cognition profile of the student cohort to ultimately adapt the course content, pedagogy, and assessment to achieve an optimal learner-centric environment.

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