FLIPPED LEARNING ANALYTICS REAL-TIME (FLARET) FRAMEWORK FOR ASSESSING STUDENT LEARNING

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ABSTRACT

In order to inculcate self-directed learning in our students, flipped learning pedagogy can be used in the classroom. The skills of self-directed learning are reflected in 2.4.5 (Self-Awareness, Metacognition and Knowledge Integration) and 2.4.6 (Lifelong Learning and Educating) of the CDIO 2.0 syllabus. Although flipped learning can improve self-direct learning skills in students, it can be difficult for the tutor to monitor all the students in the class with different learning attitudes and speed. In order to assist the tutor in managing a flipped learning class, this paper proposes a Flipped Learning Analysis in Real time (FLARET) Framework to allow a tutor in real time to assess students' self-directed learning readiness and how well they perform during flipped learning lessons. The FLARET Framework aligns with the CDIO Standard 11 which recommends the use of a variety of learning assessment methods to measure the extent to which each student achieves specified learning outcomes. An action research is conducted with the FLARET Framework and the findings from the action research will be presented in this paper.

KEYWORDS

Self-Directed Learning, Flipped Learning, CDIO Syllabus 2.4.5, CDIO Syllabus 2.4.6, Standards: 11

INTRODUCTION

In an OECD educational policy paper (OECD, 2016), it was stressed that there is a need to prepare our students for a volatile, uncertain, complex and ambiguous (VUCA) world. Laukkonen et al. (2018) proposed that meta-learning or self-directed learning, is an important skill that our students need for them to be prepared for the VUCA world. Under the CDIO 2.0 syllabus, self-directed learning is reflected under 2.4.5 (Self-Awareness, Metacognition and Knowledge Integration). Self-directed learning is also reflected under 2.4.6 (Lifelong Learning and Educating). In order to inculcate self-directed learning in our students, flipped learning pedagogy can be used. This paper will describe how flipped learning is introduced to an Environmental Science (ES) module in Singapore Polytechnic.

Flipped learning is a pedagogical approach where traditional classroom-based learning is reversed such that students are given the lecture materials before class. The classroom time is then used to deepen the student's understanding through peer and problem-solving activities facilitated by the tutor. Hence, the process of learning is less directed by the tutor but directed by the students themselves through reflecting on the topic being though and how to apply concepts discussed during the class.

First, this paper starts with a brief overview on flipped learning and how it was introduced into the ES module. Second, the paper will describe the action research and how the FLARET (Flipped Learning Analytics in Real Time) Framework was deployed. The FLARET Framework was developed for real time assessment on how students perform during the author's flipped classroom. Such learning assessment framework, aligns with the CDIO Standard 11 which recommends the use of a variety of learning assessment methods to measure the extent to which each student achieves specified learning outcomes. The benefits and challenges of deploying the FLARET Framework will also be discussed.

FLIPPING ENVIRONMENTAL SCIENCE

The (Environmental Science) ES module was running on a traditional learning framework shown in Figure 1. The ES module is a 60-hour module taught in a semester of 15 weeks. It consist of a 1-hour lecture and 3-hour tutorial session. The learning outcomes are to understanding a) the use of renewable energy technologies, b) the concept of smart buildings, c) the concept of Envelope Thermal Transfer Value (ETTV) in Green Mark, a green building rating tool, d) the design principles for passive and active design strategies, e) the requirements relating to energy optimization through the design of building envelope, f) thermal and visual comfort for building design, g) the principles of air-conditioning systems and h) the design of building systems like plumbing and rainwater drainage. According to Bloom's Taxonomy, traditional learning framework only allows student to attain lower cognitive level of understanding the concepts taught during the in-class lecture. A quiz is given each week on the concepts learnt from the previous lecture before the lecture of a new topic begins. Quizzes help to develop higher cognitive level of applying and analyzing in students. Quizzes test students on their ability to apply what they have understood in the previous lecture and also analyze the problem related to concepts taught in class. However, due to the formatting of the curriculum, lecture time is divided for both quiz and lecture. There is insufficient time for the tutor to discuss the quiz questions in more detail during class. This led to an inability to develop students' ability to apply concepts and analyze problems. The tutorial is an open design consultation session which does not focus on the concepts taught in the lecture.

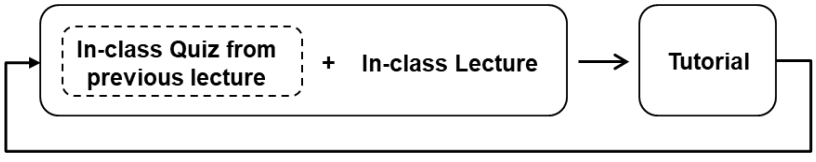

Figure 1. Traditional learning framework for ES module.

To elevate our students' level of mastery over the ES topics, we have chosen to implement flipped learning for the ES lessons in order to convert the in-class time for discussion on how to applying concepts to design problems. The flipped learning framework is shown in Figure 2. Pre-class lesson materials are uploaded on the learning management system, Blackboard, one week before class. The materials are design in the e-learning application, Articulate 360. Students are to read and prepare any questions they would like to clarify in class. The class starts with clarifying any questions on the pre-class materials. It is then followed by 25 minutes quiz. The results of the quiz can be seen real time on Blackboard, questions with high percentage of errors were brought up for discussion with the students to clarify and reinforce learning. The class ends with a survey on the concepts taught. Additional materials are given to students to develop their learning further.

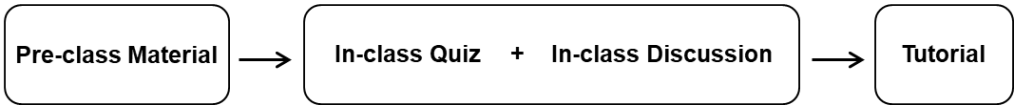

Figure 2. Flipped learning framework for ES module.

Problem Statement of Action Research

As highlighted in CDIO Standard 11, effective learning assessment uses a variety of methods to appropriately assess learning outcomes in students. The purpose of this action research is to tackle 3 learning assessment-related issues while deploying flipped learning. First, the challenge of deploying flipped learning is to manage the varied pace of students' learning. In order to roll out flipped learning lessons successfully, we would need to utilize effective learning assessments to track the level of understanding of the concepts taught in class. Second, we will need to understand the level of readiness in students for self-directed learning. A Learning Preference Assessment can be conducted to determine the Self-Directed Learning Readiness Scale (SDLRS) of each student (Guglielmino, 1978). However, the survey for SDLRS consists of more than sixty questions which will cause survey fatigue in students. Third, the results of the quizzes and surveys that accompanies the flipped learning lessons can take some time to be processed. This did not allow the tutor to quickly address the issues faced by the students in the following lesson time. For flipped learning to be successful, a real time system of collecting and diagnosing the data collected from quizzes and surveys is crucial for us to understand the needs of students and provide faster support for their learning.

Action Research Proposal

As highlighted in CDIO Standard 11, effective learning assessment uses a variety of methods. In the proposed action research, a proposed FLARET Framework shown in Figure 3, proposes the use of the Grit Scale as a self-directed learning readiness assessment and weekly in-class survey in addition to the in-class quiz used in an earlier flipped learning framework shown in Figure 2. The Grit Scale developed by Angela Duckworth (2017) has only 10 survey questions which is fast and easy for students to complete. The use of the Grit Scale as a proxy to the SDLRS, help us to better understand students' self-directed learning readiness in flipped learning and allay survey fatigue due to its short list of questions. Ruttencutter (2018) has shown a very strong and significantly positive relationship between Self-directed learning and Grit Scale. In-class quiz allows the tutor have a quick overview on whether students understand the concepts of the topics taught weekly. The in-class discussion deepens students' understanding in the concept through in-depth discussion on concepts in the lecture material. In-class surveys gets the students to open up on your learning and share any other queries that was not discussed in class.

The proposed FLARET (Flipped Learning Analytics in Real Time) Framework is deployed to address the need of real time feedback from students' quizzes and surveys. The FLARET Framework is based on the Assessing Learning in Real Time (ALERT) Framework (Tan et al. 2019; Yeou 2019) that was developed to monitor students' learning process in real time. The ALERT Framework was developed as a Joint Project by the Learning Analytics Workgroup under the Poly-ITE EdTech Committee. The goal of the framework is to empower tutors to have real time feedback from students after every lesson in order to improve teaching and learning with targeted supported. ALERT was implemented by Tan et al. (2019) for a Global Studies module in Temasek Polytechnic using a Power BI-based dashboard. Power BI is a

business analytics software by Microsoft. It provides interactive data visualization and business intelligence capabilities to create reports and dashboards.

Similarly, for this action research, Power BI is used to setup a data visualization dashboard to organize and visualize data collected from quizzes and surveys. Power BI is used as a diagnostic learning analytical tool as part of the FLARET Framework. The data visualization dashboard allows the tutor to have a quick overview on how the students are learning and performing after each flipped learning lesson. The author would like to highlight that the dashboard does not have an automatic feedback for students. The purpose of the dashboard is to assist and provide tutors with a variety of assessment techniques to "*measure the extent to which each student achieves specified learning outcomes*" as stated in CDIO Standard 11. The FLARET Framework is used to monitor students' learning from two flipped learning lesson topics: a) Envelope Thermal Transfer Value (ETTV) and b) Solar Technology for Buildings. The pre-class material, in-class quiz, in-class discussion and in-class survey are specific to the different topics taught weekly. The 10 survey questions for Grit Scale is only done once before the first lesson. The action research was setup with the following research question: what are the benefits and challenges in using the FLARET Framework with Power BI to measure the extent which each student achieves specific learning outcomes in flipped learning lessons stated in CDIO Standard 11?

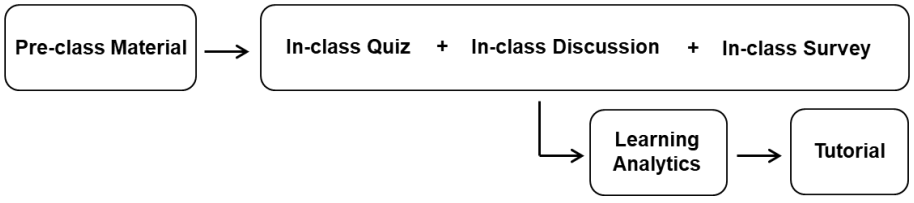

Figure 3. FLARET Framework.

ANALYSIS AND FINDINGS

Having a good overview of the data points is important for detecting anomalies to students' learning. To facilitate a good overview of the data, a Parallel Coordinates Plot (PCP) has been chosen to visualize the dataset collected. A PCP is good for visualizing and comparing multiple features of the samples in a high-dimensional dataset. The PCP of the dataset collected from 2 ES lessons are shown in Figure 4. For confidentiality reasons the students are represented by unique labels, STU_n. The PCP in Figure 4 has the following variables:

Table 1: Description of labels used in action research

Label Name	Description
STU_n	A unique student label representing each student where n = 01, 02 … n, n is the total number of students in the dataset.
Grit	Average of Grit-passion and Grit-perseverance
Grit-passion	Grit score to measure passion
Grit-perseverance	Grit score to measure perseverance
ETTV Quiz	Grade of ETTV Quiz
ETTV Survey	Averaged score of forced Likert Scale for ETTV Survey
Solar Quiz	Grades of Solar Technology Quiz
Solar Survey	Averaged score of forced Likert Scale for Solar Technology Survey

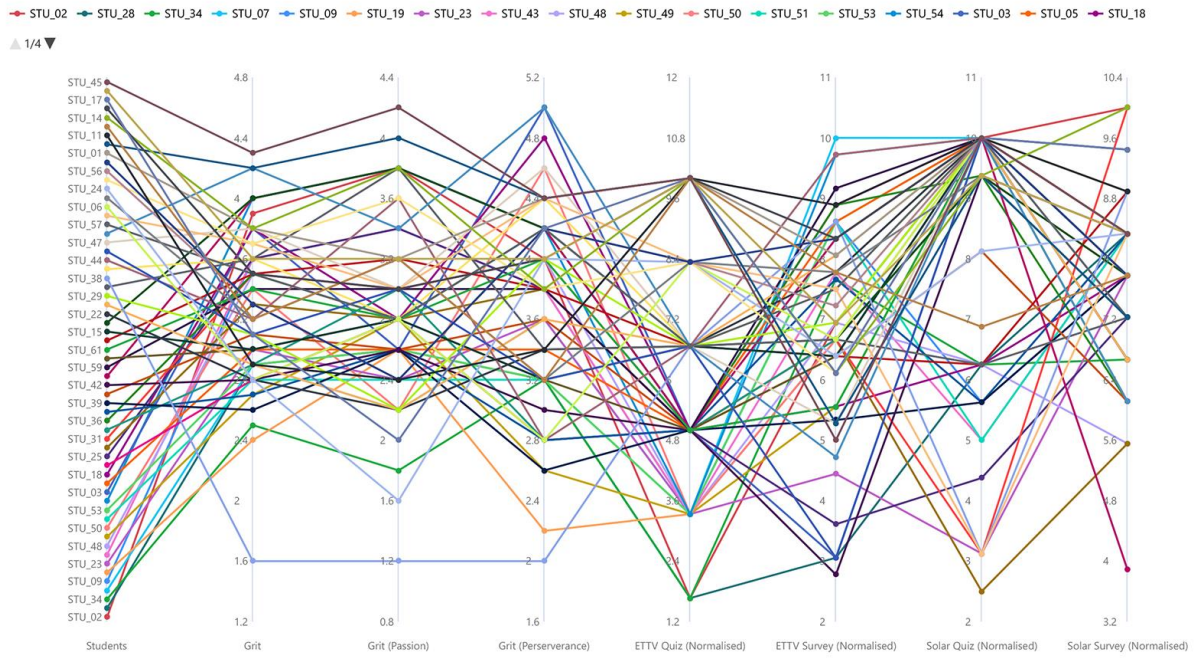

Figure 4. Parallel Coordinates Plot of dataset for 61 students in the ES module.

Grit Scale and Self-Directed Learning

Grit is defined as the passion and perseverance for long term and meaningful goals (Duckworth, 2017). It is how one perceives one's ability to persist in something that one feels passionate about and persevere even when one faces with an obstacle. Grit score of 3 is the midpoint to the 5-point scale of the Grit Scale and based on Duckworth's study, adults with Grit score of 3 is grittier than 20% of the sample population studied by Duckworth. The Grit Scale allowed us to have insights into how students perceived themselves which may affect their self-directed learning ability in flipped learning lessons. The Grit Scale helps to flag up students with potential learning motivation and allows us to pay attention to potential issues of learning. In this action research, Grit score of 3 will be the median point which we set as a minimum Grit score our students should have. Students with Grit score of 3 or less would be seen as not ready for self-directed learning.

From the PCP in Figure 4, what stood out was student STU_38 who has a substantial low Grit score of 1.6 compared to the rest of the students. We were mindful to pay more attention to the student STU_38's learning and encourages him to read the pre-class materials before lessons. To delve deeper into the Grit scores of the students, we could quickly isolate the data of 22 students, in a table with Power BI, shown in Table 1. The ability to isolate and review localized set of samples is useful for tutors to assess students' learning quickly. With reference to Table 1 showing 22 students whose Grit scores are below 3, 36% of them failed one of the two quizzes. At a closer look, although all these students had Grit scores equal or less than 3, only 7 out of the 22 students in Table 1 had Grit-Perseverance scores equal or less than 3. Of these 7 students, 43% failed at least one of the two quizzes. Of the 15 students who had Grit-Perseverance scores more than 3, 33% had at least failed one of the two quizzes. Students STU_23 and STU_28 have the two lowest ETTV survey scores which shows that they have problems understanding the lesson. This finding is also coupled with the fact they have

relatively low Grit scores which hints to the fact they have low perseverance and passion to try and figure out the lesson by themselves. Hence, it brings to attention the need for quickly intervene and encourage these students and find out what aspects of the lesson they do not understand and if extra materials or coaching are required in order for them to master the lesson content. Students STU_07, STU_19, STU_34, STU_49, STU_51, STU_53, have Grit scores less than 3 and ETTV survey score of more than 5 but failed their ETTV quiz. For these students, we need to verify if they have misunderstood how to apply these concepts in the ETTV quiz or if they are just not motivated to learn. If they have misunderstood the application of these concepts, more application-based quiz problems can be given to develop their ability to apply those concepts. If it is related to the fact that they are not motivated, these students would require coaching and encouragement to be self-directed learners.

Table 1
Students with Grit score ≤ 3.

No.	Student Tag	Grit – Passion (0 – 5)	Grit – Perseverance (0 – 5)	Grit (Average) (0 – 5)	ETTV Quiz (0 – 10)	Solar Quiz (0 – 10)	Quiz Average (0 – 10)	ETTV Survey (0 – 10)	Solar Survey (0 – 10)	Survey Average (0 – 10)
1	STU_38	1.2	2	1.6	6.7	3.1	4.9	8.6	8.9	8.75
2	STU_19	2.6	2.2	2.4	3.3	9.4	6.35	6.7	7.8	7.25
3	STU_34	1.8	3.2	2.5	1.7	6.3	4	7.7	6.7	7.2
4	STU_39	2.6	2.6	2.6	5.0	5.6	5.3	5.3	7.8	6.55
5	STU_37	2.6	2.8	2.7	5.0	5.6	5.3	7.7	8.3	8
6	STU_49	2.8	2.6	2.7	3.3	10.0	6.65	5.6	6.1	5.85
7	STU_06	2.8	2.8	2.8	8.3	10.0	9.15	6.7	8.3	7.5
8	STU_21	2.8	2.8	2.8	5.0	10.0	7.5	8.9	8.3	8.6
9	STU_22	2.2	3.4	2.8	6.7	10.0	8.35	7.8	9.4	8.6
10	STU_24	1.6	4	2.8	8.3	8.1	8.2	6.4	8.3	7.35
11	STU_42	2.6	3	2.8	5.0	9.4	7.2	2.8	8.3	5.55
12	STU_51	2.4	3.2	2.8	3.3	5.0	4.15	8.6	8.3	8.45
13	STU_07	2.2	3.6	2.9	3.3	10.0	6.65	10.0	6.1	8.05
14	STU_11	2.4	3.4	2.9	10.0	10.0	10	8.9	8.9	8.9
15	STU_26	2.2	3.6	2.9	6.7	10.0	8.35	8.1	6.7	7.4
16	STU_28	2.6	3.2	2.9	1.7	6.3	4	3.1	8.3	5.7
17	STU_33	3	2.8	2.9	5.0	9.4	7.2	6.7	7.2	6.95
18	STU_53	2.6	3.2	2.9	3.3	10.0	6.65	8.6	6.7	7.65
19	STU_05	2.6	3.4	3	5.0	10.0	7.5	8.6	7.8	8.2
20	STU_15	2.8	3.2	3	6.7	10.0	8.35	6.4	6.7	6.55
21	STU_23	2.4	3.6	3	3.3	3.1	3.2	4.4	7.8	6.1
22	STU_60	2.8	3.2	3	5.0	10.0	7.5	6.4	8.3	7.35
	Mean	2.44	3.08	2.76	5.07	8.24	6.66	7.00	7.77	7.39
	Standard Deviation	0.43	0.48	0.30	2.15	2.42	1.83	1.89	0.92	1.02

Table 2
Students with Grit score >3.

No.	Student Tag	Grit – Passion (0 – 5)	Grit – Perseverance (0 – 5)	Grit (Average) (0 – 5)	ETTV Quiz (0 – 10)	Solar Quiz (0 – 10)	Quiz Average (0 – 10)	ETTV Survey (0 – 10)	Solar Survey (0 – 10)	Survey Average (0 – 10)
1	STU_44	3.6	2.8	3.2	6.7	10.0	8.35	9.7	8.3	9
2	STU_46	3	3.2	3.1	6.7	10.0	8.35	3.1	8.9	6
3	STU_12	3.2	3.2	3.2	8.3	9.4	8.85	7.8	7.2	7.5
4	STU_13	3.2	3.2	3.2	10.0	6.9	8.45	7.8	7.8	7.8
5	STU_35	3.8	3.4	3.6	6.7	6.3	6.5	6.7	7.2	6.95
6	STU_41	2.6	3.6	3.1	5.0	8.1	6.55	6.4	6.1	6.25
7	STU_27	2.8	3.8	3.3	5.0	2.5	3.75	6.7	5.6	6.15
8	STU_59	3	3.8	3.4	5.0	10.0	7.5	9.2	6.7	7.95
9	STU_08	3.2	3.8	3.5	6.7	6.3	6.5	6.4	8.9	7.65
10	STU_09	3.4	3.8	3.6	3.3	5.6	4.45	8.6	7.8	8.2
11	STU_25	3.4	3.8	3.6	5.0	4.4	4.7	3.6	7.2	5.4
12	STU_43	3.4	3.8	3.6	3.3	5.0	4.15	7.8	8.3	8.05
13	STU_30	3.6	3.8	3.7	8.3	10.0	9.15	6.1	8.9	7.5
14	STU_14	3.8	3.8	3.8	10.0	9.4	9.7	6.1	10.0	8.05
15	STU_29	2.2	4	3.1	6.7	10.0	8.35	6.9	8.3	7.6
16	STU_16	3	4	3.5	10.0	10.0	10	8.3	8.3	8.3
17	STU_31	3	4	3.5	5.0	3.1	4.05	6.7	10.0	8.35
18	STU_48	3	4	3.5	3.3	6.3	4.8	6.9	5.6	6.25
19	STU_32	3.2	4	3.6	10.0	9.4	9.7	6.9	8.3	7.6
20	STU_02	3.8	4	3.9	1.7	10.0	5.85	6.9	10.0	8.45
21	STU_17	2	4.2	3.1	10.0	10.0	10	6.1	9.4	7.75
22	STU_56	2.4	4.2	3.3	8.3	10.0	9.15	7.2	7.8	7.5
23	STU_58	2.4	4.2	3.3	8.3	10.0	9.15	8.3	7.8	8.05
24	STU_36	2.8	4.2	3.5	5.0	9.4	7.2	8.9	6.1	7.5
25	STU_57	2.8	4.2	3.5	6.7	10.0	8.35	7.5	7.2	7.35
26	STU_20	3.8	4.2	4	6.7	9.4	8.05	6.7	7.8	7.25
27	STU_54	3.8	4.2	4	3.3	10.0	6.65	9.7	7.8	8.75
28	STU_55	3.8	4.2	4	5.0	10.0	7.5	8.3	3.9	6.1
29	STU_40	2.8	4.4	3.6	6.7	10.0	8.35	7.5	8.9	8.2
30	STU_04	3	4.4	3.7	8.3	3.1	5.7	7.5	8.3	7.9
31	STU_01	3.2	4.4	3.8	10.0	10.0	10	8.1	8.3	8.2
32	STU_10	4	4.4	4.2	10.0	9.4	9.7	5.3	7.2	6.25
33	STU_45	4.2	4.4	4.3	10.0	10.0	10	5.0	8.3	6.65
34	STU_50	2.2	4.6	3.4	3.3	10.0	6.65	6.7	8.3	7.5
35	STU_47	3	4.6	3.8	6.7	10.0	8.35	5.3	7.2	6.25
36	STU_18	2.8	4.8	3.8	5.0	6.3	5.65	5.6	7.8	6.7
37	STU_03	2.6	5	3.8	5.0	10.0	7.5	3.1	7.2	5.15
38	STU_52	3.4	5	4.2	6.7	10.0	8.35	4.7	6.1	5.4
Mean		3.13	4.04	3.58	6.58	8.47	7.53	6.81	7.76	7.29
Standard Deviation		0.53	0.48	0.32	2.36	2.33	1.86	1.60	1.27	0.98

With reference to Table 2, there are 38 students who have Grit scores more than 3 and the filtered dataset is shown in Table 2. For these 38 students, 23% failed one of the two quizzes. An interesting observation in Table 2, is that 8 students have Grit-Passion scores less than 3 but their Grit-Perseverance scores were greater than 4. These 8 students did not fail their quizzes. In addition, out of these 38 students, 21 students who have Grit-Perseverance scores that are equal or less than 4, 19% of these 21 students failed one of the two quizzes. For the 18 students out of these 39 students who have Grit (Perseverance) scores more than 4, 11% of these 18 students failed one of the two quizzes. Students STU_02, STU_09, STU_43, STU_48, STU_50, STU_54, have Grit scores above 3 and ETTV survey scores above 5. However, they failed their ETTV quiz. These students could be driven individuals but may not have grasped on how to apply the concepts from the ETTV lessons. We have to check with these students if the concepts were clearly understood and set more application-based quiz problems to develop their ability to apply those concepts. In addition, what we can observe from looking at the Grit scores is that students with higher Grit-Perseverance scores are more likely to pass the quizzes. We can postulate that the Grit-Perseverance scores are better indicator that students with higher scores in Grit (Perseverance) are more likely to pass because they are driven to perform well in their coursework.

Quizzes and Surveys

To diagnose students' learning we can look into more details on how they have performed on individual quiz questions shown in Figure 5 and 6, and correlate that with the students' responses to Survey questions. For the stacked column charts for ETTV questions in Figure 8, the group of stacked column charts allowed us to not only see which students failed the quiz but also which questions they did not answered correctly. Looking at the Stacked Column Charts, less students get ETTV questions 4, 5 and 6 correct. These questions are related to the calculation of the ETTV value for the case study given in the quiz. It is a known fact that Architecture students tends to struggle more with applying mathematical equations. Coupling this with students' responses on the individual survey questions shown in Figure 7, we could see that student STU_03 who did not perform well in the ETTV Quiz, disagrees with most of survey questions. The survey questions are shown below:

1. After reading the learning material I had a good overview and understanding of the Green Mark.
2. After reading the learning material I had a good overview and understanding of the ETTV.
3. Having a more focused explanation and discussion on key topics of Green Mark and ETTV during lecture (flipped classroom) is better than a conventional lecture where the tutor only teaches through the presentation slides.
4. Using the time in lecture to work through the ETTV calculation allows you to have a better understanding of the concept of ETTV instead of figuring it out on your own.
5. After finishing class, my understanding of ETTV has improved.
6. After finishing class, my understanding of Green Mark has improved.

Looking at student STU_03's responses to the ETTV Survey, we can tell that as he struggles to understand the topic, it has resulted in him failing the ETTV Quiz. Student STU_03 has a Grit score of 3.8, Grit (Passion) score of 2.6 and a Grit (Perseverance) score of 5 which hints that he has a relative good self-directed learning readiness.

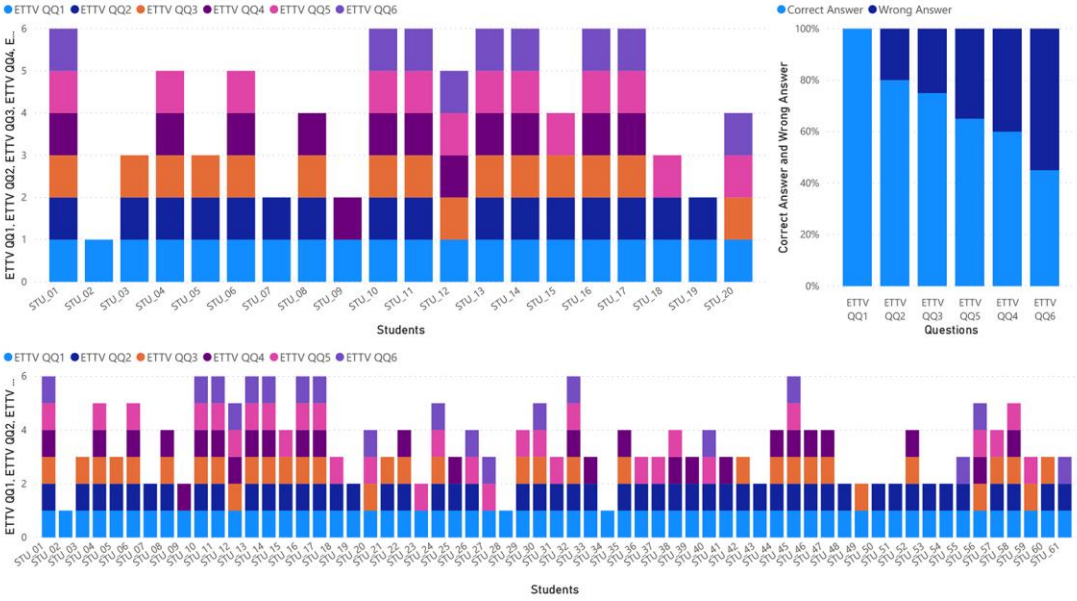

Figure 5. Stacked column charts of individual students and which questions they answered correctly for the ETTV Quiz.

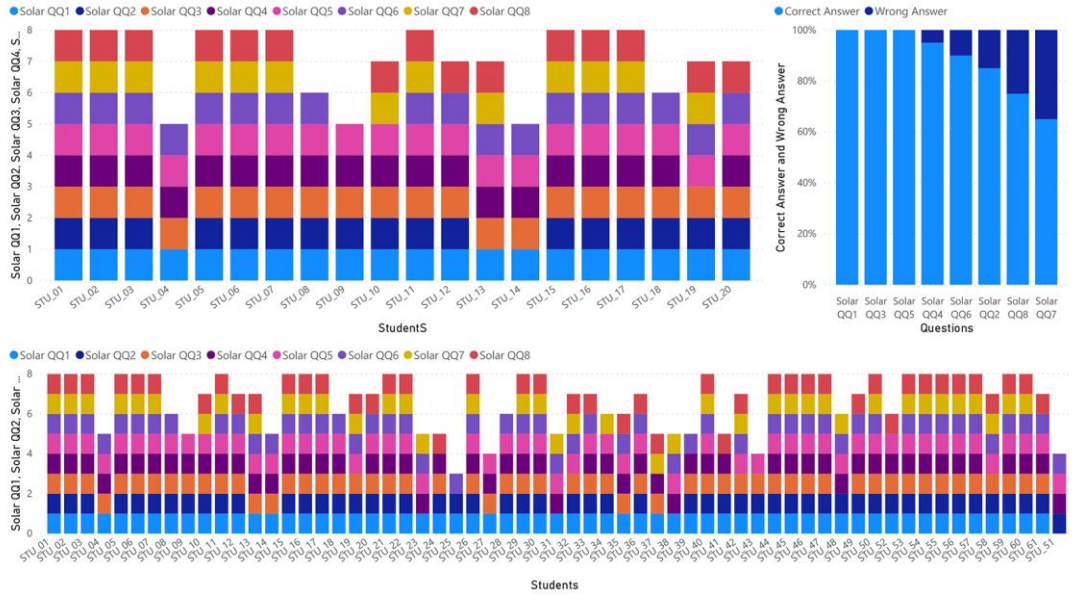

Figure 6. Stacked column charts of individual students and which questions they answered correctly for the Solar Technology Quiz.

Coupling these observations for the ETTV Quiz and Survey with the Solar Technology Quiz and Survey in Figure 7 and 8, reveals that the student STU_03 may find the ETTV calculations confusing and challenging. This is because for lesson on Solar Technology, which did not involve any calculation but is more related to basic scientific knowledge of Solar Technology, student STU_03 had full marks for the Solar Technology Quiz and he has also responded positively to the Solar Technology Survey. The survey questions are listed below:

1. After reading the learning material I had a good overview and understanding of the topic on solar technology for buildings.

2. Having a more focused explanation and discussion on key topics during lecture (flipped classroom) is better than a conventional lecture where the tutor only teaches through the presentation slides.
3. After finishing class, my understanding of the topic on solar technology for buildings has improved.

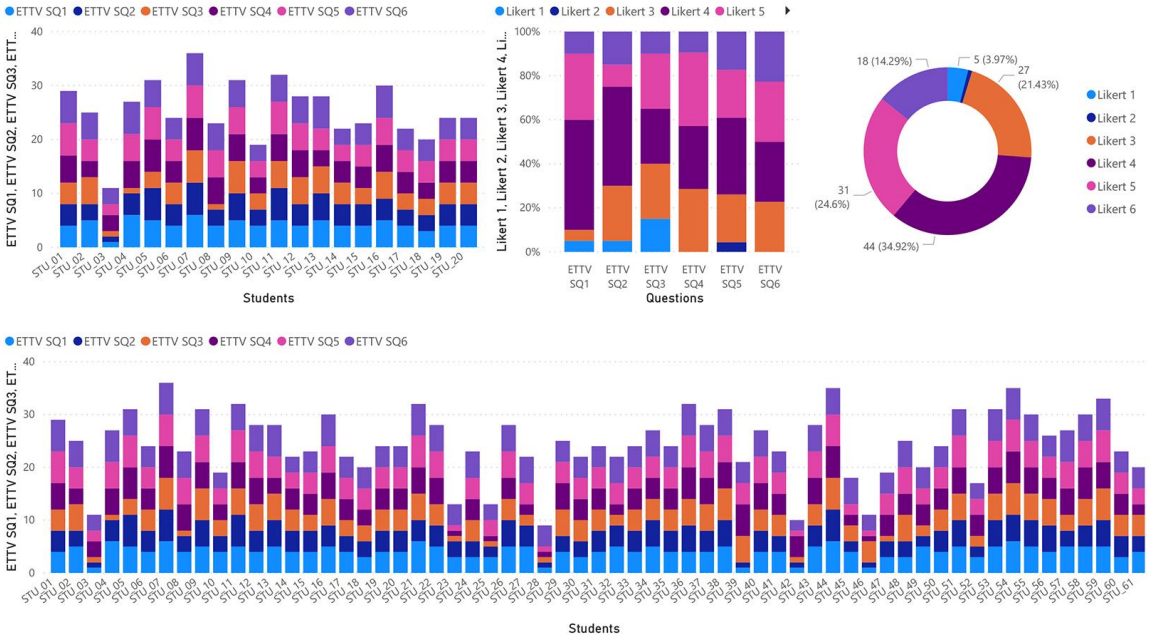

Figure 7. Stacked column charts and donut chart of students responses to ETTV survey questions.

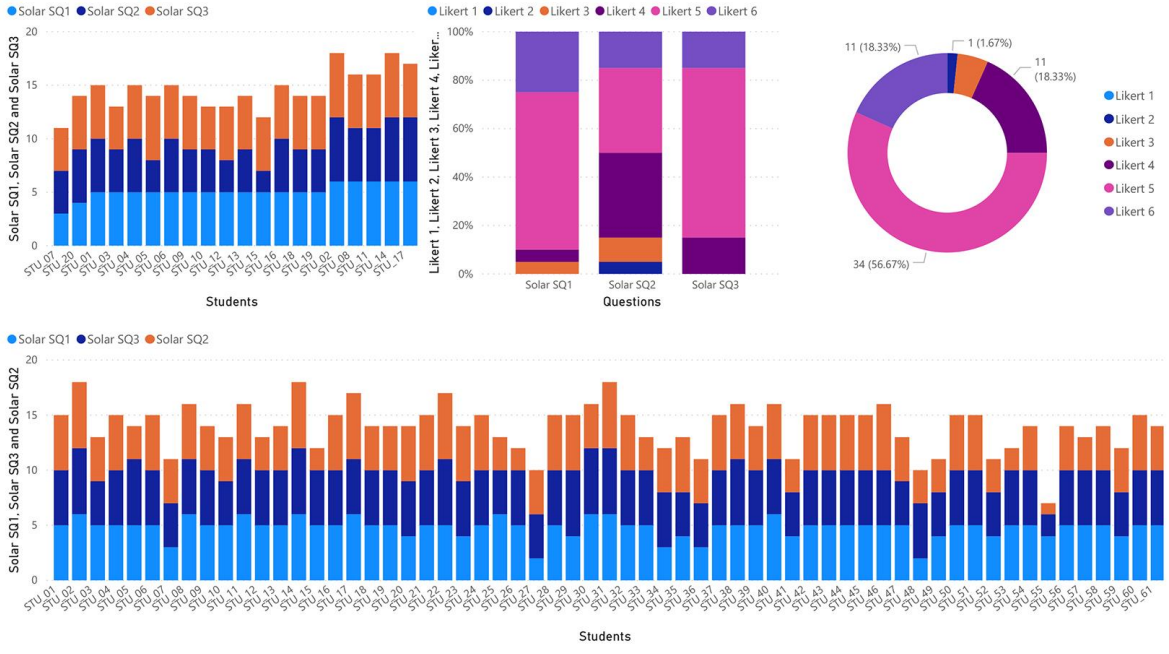

Figure 8. Stacked column charts and donut chart of students' responses to Solar Technology Survey questions.

CONCLUSION

The FLARET Framework aligns with the CDIO Standard 11 which recommends the use of a variety of learning assessment methods to measure the extent to which each student achieves specified learning outcomes. The action research was setup to evaluate the benefits and challenges of using the FLARET Framework to measure if students are achieving specific learning outcomes in flipped learning lessons. The assessment methods used are: a) the Grit Scale, b) in-class quiz and c) in-class survey. First, the FLARET Framework has three assessment methods which allows tutors to monitor students' progress in flipped learning and reveals the students self-directed learning readiness in relation to the gaps in the students' learning. The PCP provide a quick overview of the results from the three assessment methods. The comparison between the scores from the in-class quizzes and in-class surveys helped us to quickly pick up and correlate the discrepancies in students' understanding. This helps us intervene early to assist the students in their learning before their summative assessment at the end of semester. Second, the use Power BI provides us with the ability to push data to the visualization software instantaneously. However, the format of the dataset collected and the charts in Power BI have been properly synced. The big library of visualization charts to organize and visualize data in different ways to surface patterns and trends provides user with different ways to analyses the dataset. However, the process of data cleaning impede the process of analyzing the data quickly. This could be alleviate by properly setting up the quiz and survey forms such that the dataset collected are in its correct rows and columns to correlate direct to the charts setup in Power BI. This will reduce the amount of data cleaning required. Third, the analysis of the dataset collected postulates that the Grit-Perseverance score is a better indicator that students with higher scores are more likely to pass because they are more driven to perform well in their coursework. However, more studies need to be done to determine if there is a good correlation between students' performance and their Grit scores. For future work, we would need to expand the deployment of the FLARET Framework for more lesson topics to provide a wider and holistic evaluation of the entire module. In addition, other learning assessment methods could be added to complement the existing list of learning assessment methods in order to make the FLARET Framework robust.

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