MAXIMISING STUDENTS’ LEARNING THROUGH LEARNING ANALYTICS

Mark Wan Chi Ming, Chong Siew Kee

School of Electrical & Electronic Engineering, Department of Educational Development

Singapore Polytechnic

ABSTRACT

This paper documents an innovation that is employing the Conceive-Design-Implement-Operate (CDIO) Engineering Education Framework, with a strong emphasis on utilizing the affordances of technological tools – especially the use of Learning Analytics (LA) to diagnose student learning gaps and enhance instructional interventions. The School of Electrical & Electronic Engineering (EEE) implemented an *Assessing Learning in Real Time* (ALERT) strategy for a first-year module (Digital Electronics) involving 19 lecturers and 1211 students, during a Covid 19 circuit-breaker, where students were primarily in a home-based learning mode. ALERT is a joint initiative by the 5 Polytechnics and Institute of Technical Education to create a technology driven framework that incorporate the application of educational technology (EdTech) tools and data visualization software to facilitate learning. The research explored how students experienced specific interventions in real time learning (e.g., the use of readiness tests and an exit poll) through the use of learning analytics (LA) which captures, analyses, and presents student’s performance data in a visual dashboard. The findings provided valuable insights into how students experience their online learning in real time, clearly highlighting specific areas of pedagogic focus for enhancing learning effectiveness and efficiency; most notably the importance of well-crafted examples, exercises, and quiz questions to provide opportunities for sufficient practice and feedback. In summary, LA can significantly contribute to the affordances that technology offers teaching professionals in meeting the challenges of today’s rapidly changing educational landscape.

KEYWORDS

Learning Analytics, Evidence-Based Teaching, Standards: 8, 11

INTRODUCTION & RESEARCH PURPOSE

Research into how humans learn and what teaching methods work best is enhancing our capacity to design and facilitate instruction from a more evidence-based approach, much like that in engineering and medicine. In this way we can design curriculum and facilitate learning in ways that optimize attainment and engagement opportunities for an increasing range of student cohorts. Furthermore, rapid advances in educational technologies (EdTech) have provided a means to further enhance our capability to make instruction more effective, efficient, and engaging.

For example, developments in Learning Analytics (LA) provide a means to better understand what students are learning (and not learning) in specific terms; hence providing greater insight into what we can do to make our instructional approaches more effective, efficient, and personalized. LA collect, analyse, and present data in highly visual ways about learner's performance, both in real time and for future instruction. The pedagogic benefits include:

1. Identifying learners' understanding and performance levels in designated learning areas and tasks
2. Diagnosing learner's knowledge gaps and misconceptions
3. Customizing and personalization of instruction to individual learner needs and specific conceptual/skill areas.
4. Providing an ongoing evidence-base for future instructional planning.

LA are increasingly providing the capability to extract, dissect, measure and visually present specific critical data relating to students' performances on learning tasks. This highly specific feedback on what and how students are learning (and not learning) enables teaching faculty to design and facilitate more effective and personalized instructional strategies to meet immediate learning needs. The outcome of this learning arrangement is a greater visibility of the learning process in situ, both for students and teachers, and therefore maximizing student learning opportunities in cost-effective ways. In terms of CDIO adoption implementation, such technological affordances, from a sound pedagogical basis, can enhance practice across a number of the standards, especially Standard 8: Active Learning and Standard 11 Learning Assessment. Faculty will be able to provide more personalized and differentiated instruction, as well as specific real-time feedback.

Singapore Polytechnic (SP) adopted the CDIO framework from 2004, as it offered a robust curriculum development approach as well as the necessary flexibility for local customization and creative adaptation. This research supports many of the CDIO standards, especially Standard 8: Active Learning and Standard 11: Learning Assessment.

This paper outlines how the School of Electrical & Electronic Engineering (EEE) employed an Evidence-Based Teaching approach (EBT), LA and other EdTech tools to maximize learning opportunities for students. The specific research questions were:

1. Can the use of LA provide a more precise diagnosis of students learning in real time?
2. Does an EBT approach and selected EdTech tools enhance student learning?

A THEORY OF LEARNING

As Hart (1983) so aptly pointed out:

> …designing educational experiences without knowledge about how human brains learn naturally and most efficiently can be compared to designing a glove without any knowledge of the human hand. (p.4)

The research approach employed was guided by what is now widely referred to as Evidence-Based Teaching (EBT), aptly captured by Petty (2009) who argued that teaching is ready to:

> …embark on a revolution, and like medicine, abandon both custom and practice, and fashions and fads, to become evidence-based (cover page).

EBT constitutes an emerging 'science of learning' or what Sale (2015) refers to as *Pedagogic Literacy*. He outlined and illustrated 10 cognitive scientific principles (Core Principles of

Learning) that underpin effective learning design and teaching. For brevity here, these are only listed for identification (please refer to the original text for extended explanation):

1. Motivational strategies are incorporated into the design of learning experiences
2. Learning goals, objectives and proficiency expectations are clearly visible to learners
3. Learners prior knowledge is activated and connected to new learning
4. Learning is enhanced through multiple methods and presentation modes that engage the range of senses
5. Content is organized around key concepts and principles that are fundamental to understanding the structure of a subject
6. Good thinking promotes the building of understanding
7. Learning design utilizes the working of memory systems
8. The development of expertise requires deliberate practice
9. Assessment is integrated into the learning design to provide quality feedback
10. A psychological climate is created which is success orientated and fun

Another major focus of EBT owes much to the definitive work of Hattie's (2009). He synthesized over 800 meta-analyses of the influences on learning and was particularly interested not just in what factors impacted learning, but the extent of their impact - referred to as *Effect-Size*. Effect size is a way to measure the effectiveness of a particular intervention to ascertain a measure of both the *improvement* (gain) in learner achievement for a group of learners and the *variation* of learner performances expressed on a standardised scale. By taking-into-account both *improvement* and *variation* it provides information as to which interventions are most worth having.

Hattie firstly identified the typical effect sizes of schooling without specific interventions, for example, what gains in attainment are we likely to expect over a one-year academic cycle? Typically, for students moving from one year to the next, the average effect size across all students is 0.40. Hence, for Hattie, effect sizes above 0.4 are of particular interest. As a baseline an effect size of 1.0 is massive and is typically associated with:

- Advancing the learner's achievement by one year
- A two-grade leap in GCSE grades (this is a national examination system in the UK and is used for illustration of enhanced attainment in a formal assessment context).

Table 1. depicts some of the high effect methods employed in the overall instructional design strategy. These are used strategically in relation to meeting the desired learning outcomes and the identified student need in different learning contexts.

Influence	Mean Effect Size
Formative Evaluation to teachers This is where teachers take action to get feedback on their teaching and act on it	0.90
Feedback Students getting feedback on their work from the teacher, peers, self, or others.	0.73
Teacher - Student Relationships Building rapport and trust and positive expectations	0.72
Whole-class interactive teaching (including Direct instruction)	0.81

A specific approach to active learning in class, which is highly teacher led, but highly active for students. This involves summaries reviews and a range of active learning methods, including questioning	
Metacognitive Strategies Explicit teaching and use of metacognitive strategies (e.g., conscious planning, monitoring, and evaluating of thinking and learning)	0.69
Challenging goals for students Goals that students can meet through effort on their part – specific as possible; meaningful to the students involved	0.56

While there has been considerable debate on the applicability of EBT to engineering education (e.g., Borrego & Streveler, 2015), and a rapidly growing body of literature on what is referred to as Engineering Educational Research - the latter is still considered an emerging field of enquiry (Reynolds & Dacre, 2019). Hence, the extent to which engineering education is best served by so-called signature pedagogies (Schulman, 2005) is still an area for further research. The EBT perspective outlined here is perfectly compatible with the notion that different fields of study lend themselves to different pedagogic blends in terms of 'best method use'. However, this does not detract from the usefulness of a generic framework of cognitive scientific principles underpinning the design and facilitation of learning experiences in engineering education.

The Impact of Feedback on Student Learning

As noted above, Hattie recorded an averaged Effect Size of 0.73 for feedback (i.e., students getting feedback on their work from the teacher, peers, self, or others).
There are many interrelated aspects that contribute to the high impact potential of feedback on learning. Nicol & MacFarlane-Dick (2006), as quoted by Sale (2020), in synthesizing the research literature suggest the following seven principles:

Good feedback practice:

1. helps clarify what good performance is (goals, criteria, expected standards)
2. facilitates the development of self-assessment (reflection) in learning
3. delivers high-quality information to students about their learning
4. encourages teacher and peer dialogue around learning
5. encourages positive motivational beliefs and self-esteem
6. provides opportunities to close the gap between current and desired performance
7. provides information to teachers that can be used to shape teaching (p.203)

Furthermore, effective teachers - just as they adjust their communication style to different student personalities - also adjust their provision of feedback accordingly based on students' need in different contexts. For example, Hattie and Yates (2014) suggest that novices require more specific task-related corrective feedback, to be gradually replaced with more process feedback as they become increasingly proficient and self-regulated in their learning.
What this means is that initially, feedback will focus on detecting errors in what students are doing on a task, and then help to reduce and eventually eliminate these errors. Such feedback will include showing students what went wrong, examples of correct performance and ways to improve on these types of learning tasks. Process feedback is more focused on how the students are tackling the tasks given, such as their thinking (e.g., analysing, comparing, making

inferences & interpretations, evaluating) and the learning strategies they are using. In providing feedback it is often the case that both aspects are needed, and this is where the teacher's judgement and skilful action are most impactful. As students become increasingly proficient, feedback is usually more focused on their abilities to monitor and evaluate their own learning, both at cognitive and affective levels (e.g., metacognition). Questions of how much feedback and the frequency of feedback, as with all aspects of differentiated instruction, will depend on the situation and learners' readiness. As Hattie (2012) summarized:

> The key is the focus on decisions that teachers and students make during the lesson, so most of all the aim is to inform the teacher of student judgements about the key decisions: 'Should I relearn…Practice again…To what?' and so on. (p.143)

How technology can enhance feedback

Firstly, it is important to emphasize that technology per se does not enhance feedback; that must be provided by the teacher in ways framed earlier. In the more generic sense, as Moroder (2013) discovered from her experience:

> Technology does not make learning more engaging or meaningful. A great lesson does this…technology can make it more effective and efficient.

However, as identified earlier, LA enables the capability to rapidly capture, segment, and personalize student's performance data in highly visual forms. In this way faculty can see, in real-time, the 'what' and 'how' of student learning. This enables us to identify the specific feedback needed for individual students, as well as the best instructional interventions to address learning difficulties. In summary, LA can make the process of assessment much more efficient and, therefore, potentially more effective.

METHODOLOGY

The methodology involved quantitative and qualitative data on the student learning experience during the project intervention strategy. This involved the following activity stages:

1. Students do a Socrative readiness test before online class time.
2. Students take a 30-minute time-tabled schedule covid-19 formative assessment (cFA) from the Blackboard learning management system, which is completed on their webcam enabled laptop at home. Staff invigilate them using the ZOOM platform, which is a web-based video conferencing tool that allow users to meet online with video. In this way, staff can see and monitor all students on the same screen for cFA invigilation throughout the assessment.
3. Students complete a 1-minute short exit poll before class end (Microsoft TEAM synchronous session)*
4. Lecturers analyze the data further via Power BI Dashboard and plan for intervention actions.

This process is illustrated in Figure1: Real-Time Student Feedback Process by EEE.

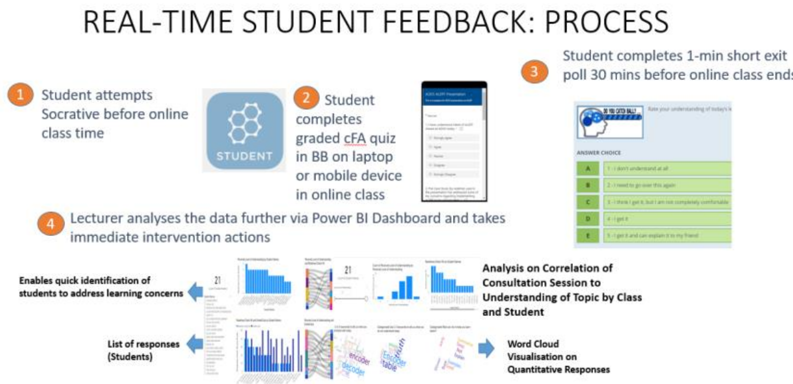


Figure1: Real-Time Student Feedback Process by EEE

A sample of the Socrative readiness test and exit poll is attached in Annexes 1 & 2.

Student feedback on these learning activities was collected by means of a short questionnaire comprising the following 3 question items:

1. How useful did you find the pre-class quiz before you attend the DE1 lesson?
2. How useful did you find the EXIT POLL conducted 30 mins before the DE1 lesson end?
3. Please help us to teach you better? You are free to speak. The sky is the limit.

RESULTS

Figure 2. Sample Dashboard of Pre-class quiz results, and Figure 3. Sample Dashboard of Exit poll results are examples of dashboards of student performances from which facilitating lecturers can interact with students, diagnose areas of learning difficulty in situ, and change aspects of their pedagogic strategy in response to perceived student learning needs.

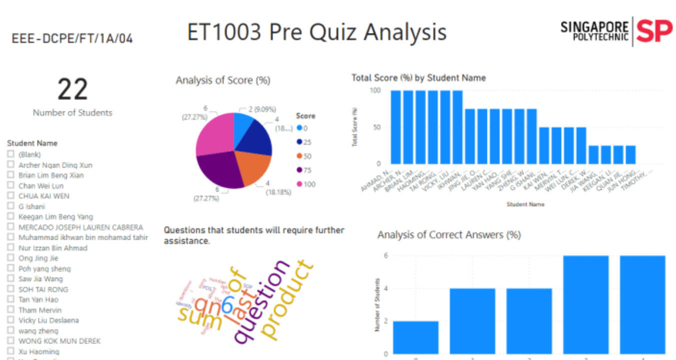


Figure 2. Sample Dashboard of Pre-class quiz results

The key purpose is to identify if students require further help with questions, so that faculty can adjust the lesson plan to address student's need.

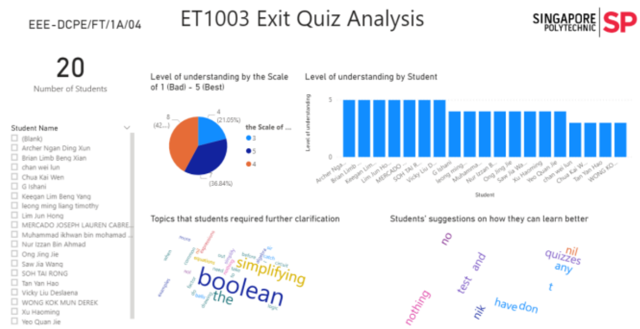


Figure 3. Sample Dashboard of Exit poll results

The key purpose is to assess students' perceived level of understanding of the lesson in real time in order to help faculty identify which topics required further clarification, and use some of the remaining time in addressing this learning need.

The student's experience of this learning intervention is depicted in the pie charts in Annex 3: Summary findings from Questions 1 & 2. They also show comparisons between the author's student group and the aggregated responses from the other student cohorts.

These findings revealed notable differences in the percentages of positive and negative responses between the two samples. For example, the percentage of 'extremely' and 'very-useful' for the pre-class quiz was 64% for the author as compared to 36% for the aggregated 'other lecturers'. Similarly, for the Exit Poll, the comparable figures were 44% as compared to 31%.

Making comparisons between the author's group and the aggregated responses of other faculty raises methodological issues. Most notable, the author had employed an EBT approach for several years on a number of research projects, while there was no clarification on the approaches used by other lecturers, apart from the broad methodology outlined prior. However, the differences invite questions for future pedagogic planning and practice in this intervention and teaching effectiveness generally.

Question 3 was an open response item to capture student's experiences, perceptions, and feelings in their own words. This data revealed that certain specific aspects of instruction are notable in terms of how students perceived usefulness to learning, which has implications for improving future practice.

Firstly, it was interesting to note that 6 responses across the samples suggested that for some students, there was a strong preference for the face-to-face classroom learning environment, starkly illustrated by one student who wrote, " I WANT GO SCHOOLLL… that is wayyy…better." However, 9 responses suggested that other students were at least satisfied and had no specific negative responses. Terms used include, "All is fine for me" and "Great so far". It is likely, in this context, that some lecturers were doing *things* that worked better than what others were doing. As there was no stratification of the faculty involved, it is not possible to make inferences and interpretations concerning faculty differences in terms of training or other specific demographic characteristics, beyond the engineering context.

However, much pedagogic value can be derived from the student's responses to features they liked (and did not like) concerning instructional practices during the intervention. For example, 29 responses for improvement related to more and better focused questions, examples, and activities in which they could do sufficient practice with feedback to build understanding. Also, several negative comments related to a lack of clarity and/or too fast a pace in the instruction provided. Illustrative comments include:

“We need more practice”; “Go through more examples”; “Give us answer key to check”
“Do a brief run-through of each chapter every lesson”; “Ask more questions”.

IMPLICATIONS FOR PRACTICE

The results from this research intervention offer practical insights into how best to utilize LA and other EdTech tools to maximize student feedback. These are summarized in the following sub-sections:

Applying EBT in planning and evaluating instruction

While comparisons between the student feedback cohorts are not generalizable, they do support the notion that an EBT approach may further advance the affordances of technology interventions – whether specifically using learning analytics or EdTech tools generally. The higher scores in the quantitative data of the author’s cohort is further supported by the qualitative data in terms of the student feedback. Very few negative responses were identified e.g., only 2 responses relating to the pace being fast).

Pedagogically, EBT enables instructional design and facilitation to more effective, efficient, and engaging. This facilitates a common pedagogic language among faculty for improving, customizing, and differentiating of instruction for more students. It also enables better utilization of EdTech affordances in maximizing different aspects of the learning process.

Identifying more precisely and efficiently student learning gaps and misconceptions

This is a clear affordance of using the LA technology employed. From the dashboard, it is possible to identify students who are having difficulty with specific concepts and topic areas, as it will flash out their names and results. While cFA is only viable on weeks 3, 5, 11, 13, 15, 17, the immediate intervention using the readiness quiz result and exit poll collected each week makes the aggregated data useful for future lesson design, as it enables more specific inferences and interpretations on the ‘what’ and ‘how’ of student learning, and why they may not understand certain topics.

The dashboard data enables monitoring student’s learning in real time, offering more insightful diagnosis of learning problems and facilitating effective pedagogic interventions. This is illustrated below in Table 2. Summary Examples of Using the Dashboard for Real-time Pedagogic Interventions.

Learning situation	Specific examples from using Power Bi visualisation	Action	Pedagogic Impact
Students may not prepare well for pre-class activities	A student only scored 50% in the pre-class quiz, and rated himself 3/5 in the perceived level of understanding.	Provided feedback to make him aware of his lack of understanding and encouraged him to persist and ask questions during the 30 minutes of Q&A time before end of class.	He subsequently scored 9/10 in his cFA2 and scored 93% in cMST.
Students perform poorly in pre-class tests but	A student scores 25% in the pre-class quiz, but rated himself 4/5 in the	Intervened with task specific questions and positive feedback,	This student subsequently scored 62% in the cMST, which

over-estimates own level of understanding	perceived level of understanding.	monitoring performance over the duration of the instructional period.	he may have failed without a focused intervention.
Students may be over-confident and not do sufficient preparation for a lesson or test	A student scored 50% in the pre-class quiz and rated himself 4/5 in the perceived level of understanding. He scored 9/10 in his cFA2 quiz.	He asked concept questions, which I thought he understood.	He only scored 31% in cMST. It may be that he did not prepare well, or should have been monitored more fully. Hence need to be aware of this in future.

This enables faculty to quickly identify weaker potentially at-risk of failure students, and take immediately take appropriate action to remediate the learning gaps/misconceptions with an instructional intervention(s). This can be done in a number of ways (e.g., uploading a new video using another scenario/example to explain the concept; additional self-assessment quiz questions; answer templates providing specific feedback).

Initially, the faculty conducted the exit poll 5 minutes before the end of the lesson, downloaded the results after class, then analysed the student's responses in order to gain evidence-based insight into their learning strategies, notable areas of difficulty, and how best to adjust the instructional strategy for the upcoming lessons. However, the faculty subsequently decided that it would be pedagogically more useful to do the exit poll 30 minutes before the class end, as they can then act upon the emerging data in real time; hence do 'on the spot' analysis of the student learning, and better identify what seems to be the immediate concerns relating to key conceptual understanding. They then can use some of the remaining direct contact time to do focused remediation based on this timely feedback.

Similarly, while the use of Socrative has a number of pedagogic affordances, including activating prior knowledge, key concept testing and feedback, and aiding instructional planning, it only enables 1 public room for 1 lecturer. As some faculty teach more than one class there is the problem of collecting data for the readiness check test and exit poll. At present, the faculty have to manually key in the data for cFA. Also, due to the circuit breaker, faculty had limited time to prepare for the ALERT project, but still have to quickly shift from face-to-face lessons to home-based learning and integrate ALERT into their lesson plans.

It is essential, therefore, to use an EdTech tool that automates cFA, as this will be time- saving for large scale implementation, which is a necessity for the 'ALERT' process to be viably implemented. Once achieved, faculty can monitor students' virtual classroom learning experience to better inform instructional approaches and module design; hence providing a systemic enhancement for real-time student feedback to maximize learning.

Enhancing teacher expertise through professional development

While this intervention involved 19 faculty from the School of EEE, there is a need to upscale professional learning to the wider institutional context, developing what Hargreaves and Fullan (2012) refer to as 'Professional Capital' (i.e., institution-wide faculty expertise).
In the present context of SP, we are developing what Hargreaves and Fullan (2012) refer to as 'Human Capital' (i.e., individual faculty achieving high expertise), and there has been sharing of learning through staff development briefings and workshops. Hence, we are also achieving

some degree of what Hargreaves and Fullan frame as 'Social Capital' (i.e., increasing numbers of faculty sharing their work and learning experiences).

For the future, we need to continue building on the social capital presently being developed, to foster a learning community committed to achieving sufficient Professional Capital for the longer-term educational goal of building a unified pedagogic and EdTech approach to learning and teaching – irrespective of delivery mode.

LIMITATIONS OF THIS RESEARCH & FUTURE LEARNING

As previously noted, while the author had considerable experience in applying the principles and practices of EBT, there is limited knowledge of how well-prepared other faculty were in this intervention; hence, comparisons between the two samples are limited. Also, while questions 1 and 2 elicited quantitative feedback on the usefulness to learning of the readiness test and exit poll, they were limited in terms of unpacking the student experience in more precise forms that would have enabled a deeper understanding on how students were learning. Furthermore, as student performance was not measured, their perceptions cannot be corroborated in terms of meeting specific learning outcomes. This was, in part, the result of time pressure to get the intervention moving quickly in the context of rapid school closure. These are areas for future improvement in both methodology and scope.

SUMMARY

This paper has outlined a pedagogic intervention, initiated in response to the challenge of providing effective and efficient online learning in the Covid 19 pandemic. The research suggests that learning analytics, when employed from an EBT approach, can play a significant role in using EdTech affordances to maximise student learning outcomes.

REFERENCES

Borrego, M., & Streveler, R.A., (2015). Preparing engineering educators for engineering education research. In *Cambridge Handbook of Engineering Education Research* (pp. 457-474). Cambridge University Press.
Crawley, E., Malmqvist, J., Ostlund, S., Brodeur, D., (2007). *Rethinking Engineering Education*. Springer, New York.
Hargreaves, A., & Fullan, M. (2012). *Professional Capital: Transforming Teaching in Every School*. Teachers College Press, New York.
Hart, L. A. (1983). *Human brain and human learning*. Longman, New York.
Hattie, J. (2009) *Visible Learning*. Routledge, New York.
Hattie, J. (2012). *Visible Learning For Teachers: Maximizing Impact On Learning*. Routledge, London.
Hattie, J., & Yates, G. C. R. (2014). *Visible Learning and the Science of How we Learn*. Routledge, New York.
Moroder, K. (2013). You Tube video, *Learning That Technology Is Not A Silver Bullet: Ed Tech Challenge Intro (1/4)*, available at https://www.youtube.com/watch?v=pXkkoAVrmvo&index=4&list=UUQHWPc4O7z68ZqZwMjgNznA (Last accessed 22 December 2020).
Petty, G. (2009) *Evidence-Based Teaching: A Practical Approach.* Nelson Thornes, Cheltenham.
Reynolds, D., & Dacre, N., (2019). Interdisciplinary Research Methodologies in Engineering Education Research, available at http://users.sussex.ac.uk/~nd281/papers/2019-Reynolds_Dacre-

Interdisciplinary_Research_Methodologies_in_Engineering_Education_Research-EERN.pdf (Last accessed 25 March 2021).
Sale, D. (2015). *Creative Teaching: An Evidence-Based Approach*. Springer, New York.
Sale, D. (2020). *Creative Teachers: Self-directed Learners*. Springer, New York.
Shulman, L.S.(2005). Signature Pedagogies in the Professions. *Daedalus* Vol. 134, No. 3, On Professions & Professionals (Summer, 2005), pp. 52-59.
Wan, M., Chong, SK., (2018). Using the Evidence-based Reflective Practice Tool to Enhance Professional Practice. Paper presented at *International Symposium on Advances in Technology Education*, Japan (September 17-20, 2019).

BIOGRAPHICAL INFORMATION

Mark Wan is a Specialist (Teaching and Learning) / Senior Lecturer from School of Electrical and Electronic Engineering, Singapore Polytechnic. He consistently looks for different ways to bring his classroom to life, utilizing an evidence-based approach to pedagogy and experimenting with EdTech tools to better engage and support student's learning. His research interests include active learning pedagogies, blended learning (flipped classroom), and enhancing students' intrinsic motivation in engineering modules.

Chong Siew Kee is an Educational Technologist from the Department of Educational Development at Singapore Polytechnic (SP). She provides pedagogic & technical support to schools and works closely with lecturers to integrate educational technology in their classes to enhance learning experiences and outcomes. She currently supports flipped learning, team-based learning, evidence-based learning, learning analytics and traineeship programme in SP.

Corresponding author

Mark Wan Chi Ming
School of Electrical and Electronics Engineering
Singapore Polytechnic
500 Dover Road
Singapore 139651
mark_wan@sp.edu.sg

Annex 1: A sample of the Socrative readiness test.

3. Which of the following is digital quantity?

- A The amount of money in a wallet
- B Temperature of a room
- C Depth of a submarine in the ocean
- D Blood pressure

4. What is the positional value of digit '7' in decimal 27.1?

- A 1
- B 10
- C 100
- D 1000

5. Convert 1011_2 to its equivalent decimal value.

- A 10
- B 11
- C 12
- D 13

List any questions from the above that you will require further assistance.

Annex 2: A sample of the Exit poll

1 of 2

Rate your understanding of today's online lesson in the Scale of 1 to 5.

5 - I get it and can explain it to my friend
4 - I get it
3 - I think I get it, but I am not completely comfortable
2 - I need to go over this again
1 - I don't understand at all

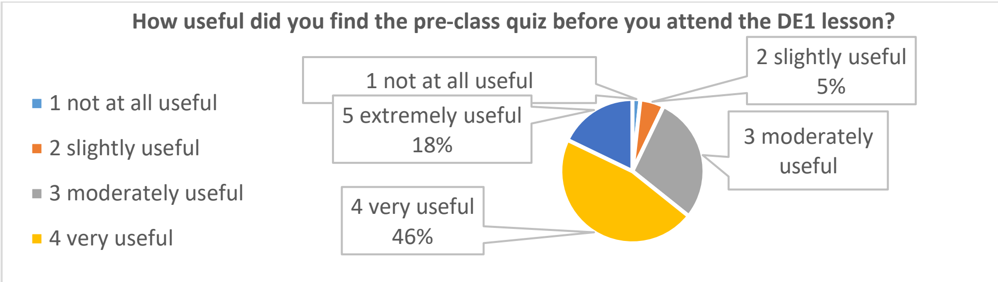
- A 5
- B 4
- C 3
- D 2
- E 1

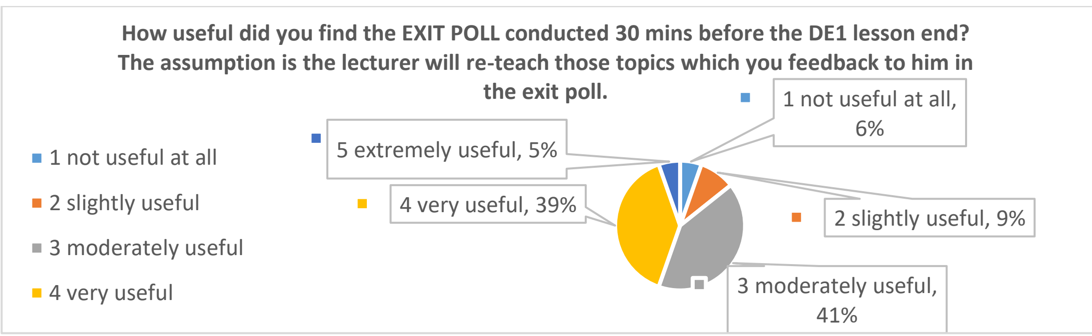
2 of 2

Use 3 to 5 **keywords** to tell us which topic you need further clarification.

Annex 3: Summary findings from Questions 1 & 2.

Students taught by the author (56 responses)





Students taught by other lecturers (486 responses)