Prompting the use of online application on smartphone (integral calculator) in learning integration techniques

IOP Conf. Series: Journal of Physics: Conf. Series **1200** (2019) 012017 doi:10.1088/1742-6596/1200/1/012017

Prompting the use of online application on smartphone (integral calculator) in learning integration techniques

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Abstract. The bondage of smartphone should be overcome wisely. In fact, students could not be separated from smartphone in the class. Therefore, as an educator we can use it to create a learning process of integration using application in the Internet. This study aims to develop classroom activities that support engineering students for learning integral using Integral Calculator in Internet. Design research was chose as an appropriate method to achieve the goals since this study will provide a descriptive learning evidence how the students use the application to understand integration technique. Around thirty-eight engineering students in Adisutjipto College of Technology that divided in 10 groups involved in this study. The teaching experiment result of cycle 1 showed that only a few students knew about Integral Calculator before this study. At the first, they were amazed and thought it was very useful to find the answer. Later on, when they asked to understand the steps given by this application they found some difficulties. However, with small clue they can understand it. In other words, this application really helpful for students to get the calculation of integral problems, but students still need guidance from teacher or friends to process the steps. Therefore, the use of integral calculator fits best for classroom activities while teacher or group discussion could lead students to comprehend integral techniques.

1. Introduction

Nowadays, everybody has smartphone. In any occasion, we can see adults, kids, man or woman bring smartphone in their hands. They seemed inseparable although in restroom. Moreover, the dramatic growth of smartphone users has also affected the use of it in the classroom. A research showed that 95% of students bring their phones to class every day, 92% use their phones to text message during class time, and 10% admit they have texted during an exam on at least one occasion [1]. Almost all students in the previous research believed that lecturer is unaware of their activities in texting or other smartphone activities in the classroom. These students said that they could browse the internet, send pictures or access social networks while learning in the class. This research promoted a study that students in college tend to have negative attitudes toward smartphones in the classroom [2]. Therefore, it suggested formal policies about the use of smartphone in the learning process especially in classroom.

Meanwhile, a study argued that college and universities tend to not to ban the use of smartphone as a policy [3]. They just leave it to the discretion of individual faculty since many are not sure how to handle this issue or some may not even be aware there is a problem. Smartphone may be able to contribute in some way for learning process in some courses. For example, English teacher can ask the

students to find the translation using their smartphone instead of bringing dictionary. Since many students usually leaves their dictionary at home rather than their phone.

Actually, the use of technologies in the classroom for teaching and learning process has been facilitated by learning model, called blended learning. There are many ways to define what blended learning is but the complete definition is provided by Victorian Schools [4] that has conducted the blended learning for a long time without realize it. Blended learning refers to the planned implementation of a learning model that integrates student-centred, traditional in-class learning with other flexible learning methodologies using mobile and web-based online (especially collaborative) approaches to realize strategic advantages for the education system.

Integral Calculator is an application on Internet created by an IT services, David Scherfgen from Germany [5]. This calculator allows the users to calculate integrals of functions online for free. This also provide full working (step-by-step integration) to make the users understand the solution. Almost all common integration techniques are supported by this calculator. Interactive graphs/plots are provided in order to help visualize and better understand the functions. The calculator applies the same integration techniques that a human would apply using Maxima's own programming language which has more than 16000 lines of code.

Today Internet is being daily need for people around the word. Based on survey that held by Internet Research Site Worlds Stats in 2015, Indonesia stand as the 4th Asian Internet user. It is believed to rise significantly in 2018 since most people in Indonesia have smartphone that need internet connection. Furthermore, Internet does not only used by workers but also students. Students always search everything by Internet. When they give a task, they will ask Internet even in classroom. Thus, in order to reduce the negative effect of the smartphone use in classroom, students should be asked to learn some material from their own smartphone such as Calculus in Mathematics.

Calculus is one of the fundamental courses in mathematics and has been mandatory class for almost all major in Universities except arts, language and social major. The science students definitely learn Calculus in their first and second years. Since it provides a foundation and a gateway for more advanced mathematics [6], Calculus is being a vital important to the success of any science and engineering fields, including engineering technology [7]. Integral is one of the two fundamental concepts in Calculus. Therefore, it is important for students taking engineering and science to expert in Integral. Several research shown that students still have difficulties in understanding not only the concept of integral in Calculus but also the techniques [8].

Based on the earlier research, we can say that the use of smartphone could distract the learning process in classroom. In the other hand, learning integral is not always easy but it is quite important for engineering students. By the trend of students that using smartphone in the classroom, why not asked them to use it for learning process. There is several research about the use of technology in learning process for example maple for learning integral, Matlab for learning linear algebra and so on. Even, Internet free application also built for helping the students to deal with mathematics lesson. For instance, solving integral by using online calculator from Symbolab, Wolfram alpha, Emathweb, Freemathelp, Mathportal.org, Mathway and others.

From these online calculators, students could get the answer easily but just few of them also give the process for the users. Integral Calculator an online application that not only solving integral but also providing the steps. Therefore, this study described how the use of Integral Calculator helps engineering students learn integration techniques, focusing on Partial Integral and Substitution.

2. Research Methodology

This study used design research, an approach that envisions a tighter, more rigorous connection between learning principles and feature of the educational innovation [9]. The purpose of this study is in line with the purpose of design research to discover ways to develop a design, such as learning activity, based on theory and to figure the effectiveness of this design in practice. Hence, the design of instructional activities of this study will help to improve the mathematics education toward the effectiveness of online technology for learning process of Integration Techniques. The innovative design will give such an

intervention for students to use technology smartly in learning integration techniques but still considerate the mathematics methods (steps by steps), focusing on Partial Integration and Substitution.

There are three concrete phases to conduct design research based on Gravemeijer and Cobb [10]. Those are preparing for the experiment, experimenting in the classroom, and conducting retrospective analyses. These phases conducted in two cycles. The first cycle usually did to try the instructional activities and to test the conjectures of the hypothetical learning trajectories. Then after revising based on the retrospective analysis, the instructional activities conducted as second cycle. However, this study focused on the preliminary teaching experiments or cycle 1. This first cycle carried out in order to investigate students' thinking of the activities using integral calculator compared to the conjectures. The participants in this cycle will be different with the second cycle (full experiment).

2.1. The Instructional Classroom Activities

The descriptive will just concern on cycle 1 in this study. Thirty-eighth students of the second years in Matematika Teknik class joined this study. They have learned about integral in their earlier semester. This study wants to know how this integral calculator would help them to recall their integral knowledge. Since they will need integral for learning other aeronautics lesson. They did the instructional activities in this cycle in a heterogeneous group consists of four students. They have to do five problems using their own way.

$$\int x(x+3)^3\,dx \qquad \text{Problem (1)}$$

$$\int x(x^2+3)^8\,dx \qquad \text{Problem (2)}$$

$$\int x\,e^x\,dx \qquad \text{Problem (3)}$$

$$\int x\,e^{x^2}\,dx \qquad \text{Problem (4)}$$

$$\int x^3\,e^{x^2}\,dx \qquad \text{Problem (5)}$$

Afterwards they questioned whether they are familiar with one of Integral Application in Internet called Integral Calculator or not. They asked to try this application to recheck the answer. Next, this student would compare the Integral Calculator with their answers and analyze it.

3. Result

This research found that more than half students in this cycle 1 study did not know about integral calculator in Internet. It is kind of proof that students still use smartphone for social media only. Since today people always search everything on Internet, why these students do not look for the answer of integral in Internet so they most likely will find integral calculator. Some of them may unwilling to find the lecturer material in Internet.

Furthermore, the question about the impact of the application showed that most of them still doubt about the function of Integral Calculator to help them understanding the integration technique. Their reasoning is just trivial, such as the long procedure, the unclear steps due to the skipped steps and the different methods with their usual. Again, this showed how pampered they are. This response signifies student's habit to wait the lecturer explanation. They only want to get a short, simple, or shortcut how to get answers without understanding the procedure.

Table 1. The general result of the instructional activities

Group	Do you know integral calculator?		**Impact of the application**	
	Know	Do not Know	Do integral calculator online application help you to understand integration technique?	If you learn integration techniques just by the integral calculator, could you do another integral problem?

A	√		Yes, because it helps to check answer but can make students lazy	It could help as guidance to solve the problem, especially the difficult one.
B	√		Yes, because it helps to understand	No, Because there are many skipped steps
C		√	Yes, because it is explained very detail and	Yes, because it is explained very detail
D		√	No, because the answer of the application with our answer is different.	No, we believed there are special problems that could not solve by integral calculator.
E		√	Yes, since it can simplify the answer.	Sometimes, since every problem have different methods.
F	√		Yes, if the method is compatible with our methods and could help to check the answer.	No, since the apps tends to choose the easiest methods although has long procedure and usually not as students wish.
G		√	Yes, It has clear explanation in every steps.	Yes, It has clear explanation in every steps.
H	√		Yes, It provides step by step to solve integral problem.	No, The steps different with what we used to learn.
I		√	Yes, it helps but still confuse to understand the steps	No, since it is still easier to understand oral explanation.
J		√	Yes, it is very helpful	Maybe it is helpful, but depends on student' level of understanding.

This cycle asked the students to solve the integral by using their own technique. Then they compare it with the answer using Integral Calculator. They differentiate between their strategy and the strategy of application. They tried to analyse the pattern of the application. They found that Integral Calculator tend to use u-substitution than partial integral. Actually, it was the same with what students thinking. Many of students tried u-substitution first to solve the problem, then if it does not work they usually use partial integral. But for Integral Calculator, it used u-substitution for question that students will use integral partial such as problem (1) (see figure 1). Moreover, when students looked closely the u-substitution used in problem (1) by Integral Calculator, it was different with u-substitution they used to do all the time. We used it as an interesting fact to be discussed in the classroom discussion. Students expressed their opinion about the problem, others responded, teacher clarified so the discussion becomes meaningful. From the discussion, we got some interesting findings as will be discussed in the following paragraph.

$$\int x(x+3)^3\,dx$$

With Steps!

Substitute $u = x + 3 \longrightarrow dx = du$ (Steps):

$$= \int (u-3)\,u^3\,du$$

Expand:

$$= \int \left(u^4 - 3u^3\right) du$$

Apply linearity:

$$= \int u^4\,du - 3\int u^3\,du$$

Plug in solved integrals:

$$\int u^4\,du - 3\int u^3\,du$$

$$= \frac{u^5}{5} - \frac{3u^4}{4}$$

Undo substitution $u = x + 3$:

$$= \frac{(x+3)^5}{5} - \frac{3(x+3)^4}{4}$$

Rewrite/simplify:

$$= \frac{(x+3)^4\,(4x-3)}{20} + C$$

Figure 1. The method to solve the problem (1) by integral calculator

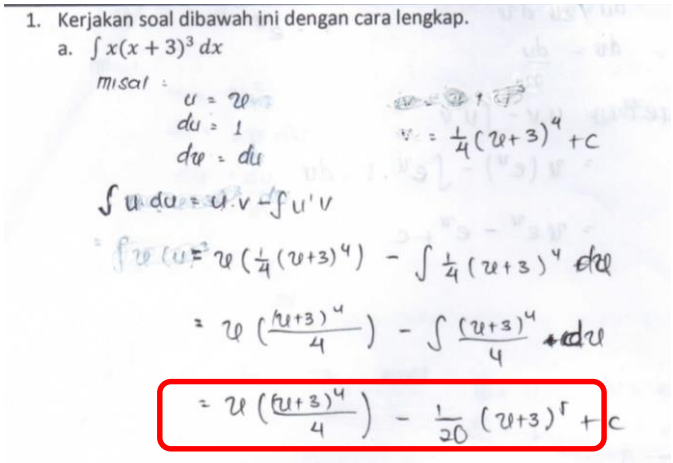

Figure 2. The method to solve the problem (1) by a student

Based on figure 1, there were many comments asked by students such as where (u-3) comes from, it is a long procedure and the final answer is not the same. First, the (u - 3) come from substitute u = x + 3 that make x = (u - 3). So the (u - 3) is substituting x. Next, the steps of integral calculator are less than student's answer since it does not need to find u, du, v, dv therefore it becomes simpler. Then, talking about the different final answer, they just need to make it in the same denominator. Then they will get the same answer. Those kind of things makes students doubt about the advantages of integral calculator. It has many hidden messages that have to find out. Students usually asked about, "How could this happen?", "Why is that so?", "How come?", "What caused it?","Is that true?", and other suspicious questions. Practically, we can use it as good stimulation for students to have mathematical thinking. Sometimes teacher just need to push their students to think a little bit harder. Actually, our brain is in use most of the time, even when we are performing a very simple action like resting or sleeping.

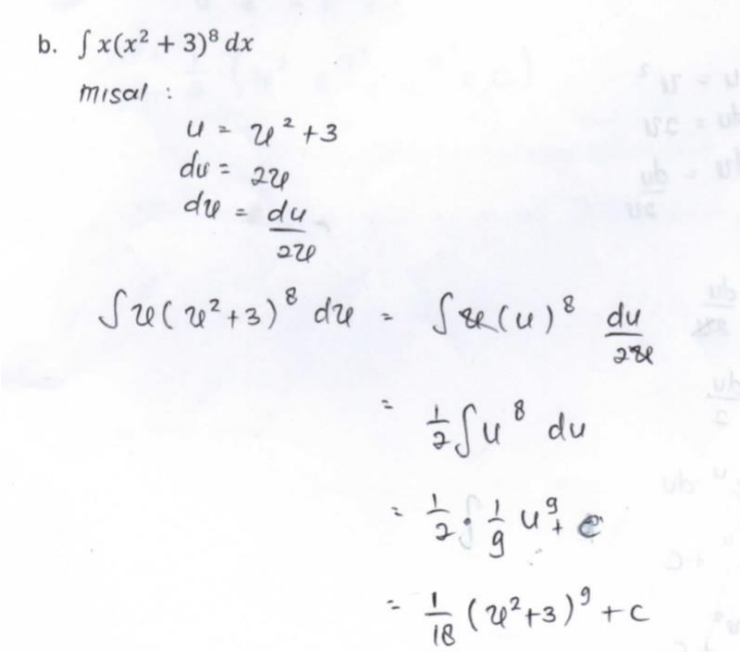

Figure 3. The u-substitution techniques most of students used to do

Moreover, just 40 % student of this research who have known application of Integral Calculator. From this number, 75% of them questioned about the steps shown by Integral Calculator. Some of them argued that some steps disappear on the application. It makes they have to find how does it work to understand the steps otherwise they could not follow the rules given. For example, the problem (5) shown in the figure 4 below.

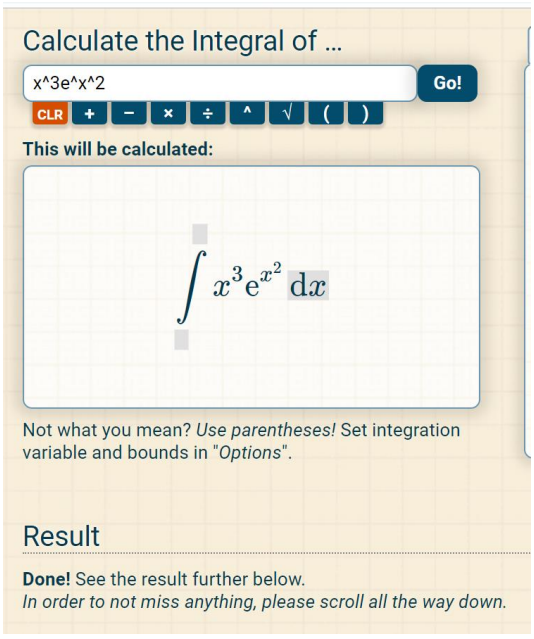

Figure 4.a. The original version of solution of problem (5) using Integral Calculator online application

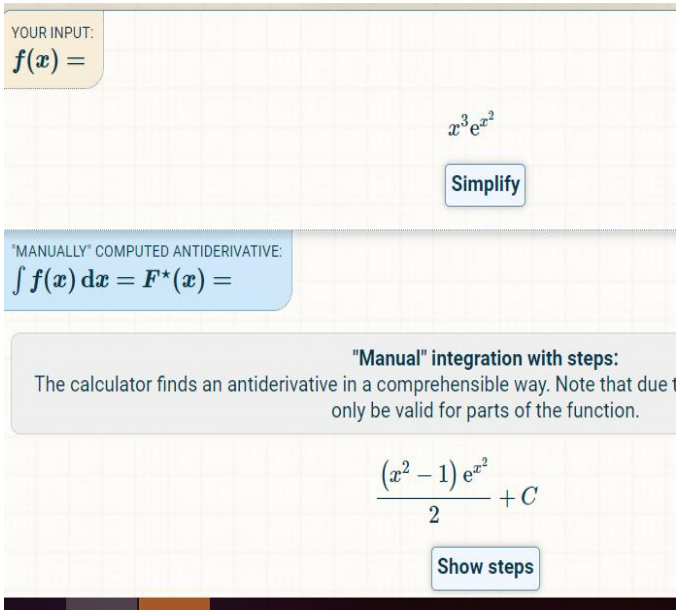

Figure 4.b. The original version of solution of problem (5) using Integral Calculator online application

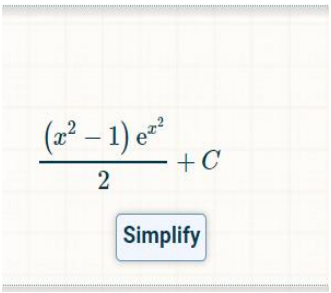

Figure 4.c. The original version of solution of problem (5) using Integral Calculator online application

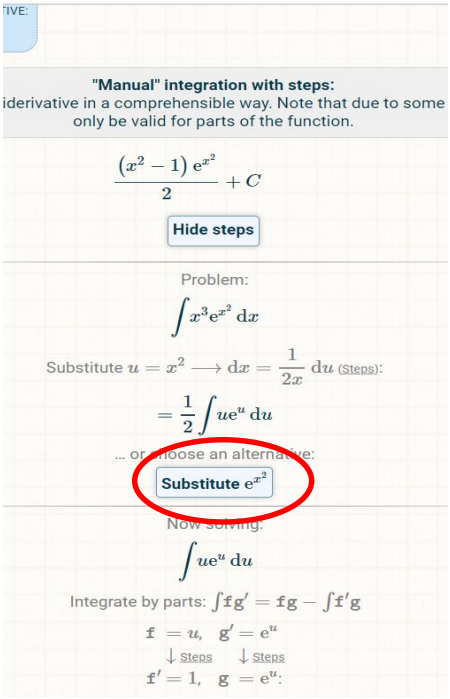

Figure 4.d. The original version of solution of problem (5) using Integral Calculator online application

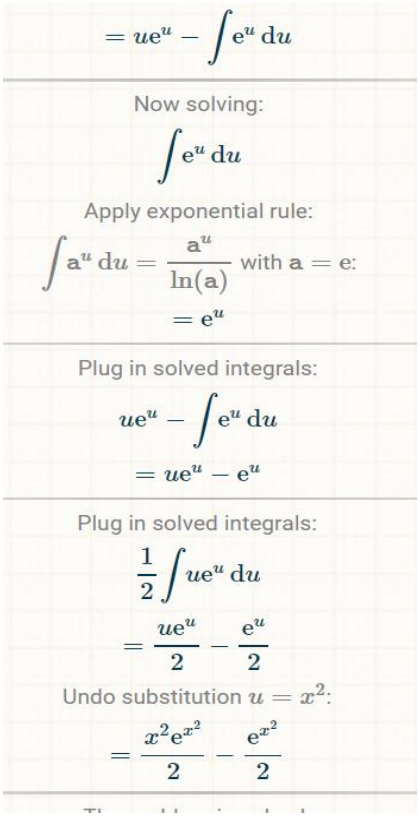

Figure 4.e. The original version of solution of problem (5) using Integral Calculator online application

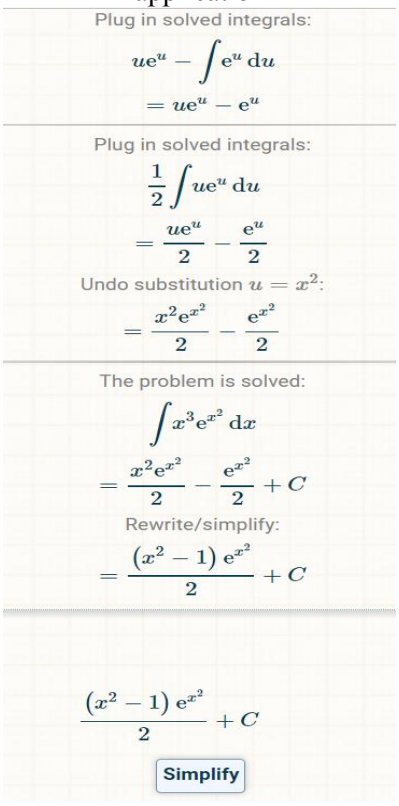

Figure 4.f. The original version of solution of problem (5) using Integral Calculator online application

Based on the figure 4.a until 4.f, it showed the complete steps to solve the problem by using Integral Calculator. Meanwhile, this application also gave alternative ways to solve the problem. By clicking **"or choose an alternative, Substitute e^{x^2}"** (the red marks in the figure 4.d), the steps will be totally different but still lead to the same answer as figure 5 below.

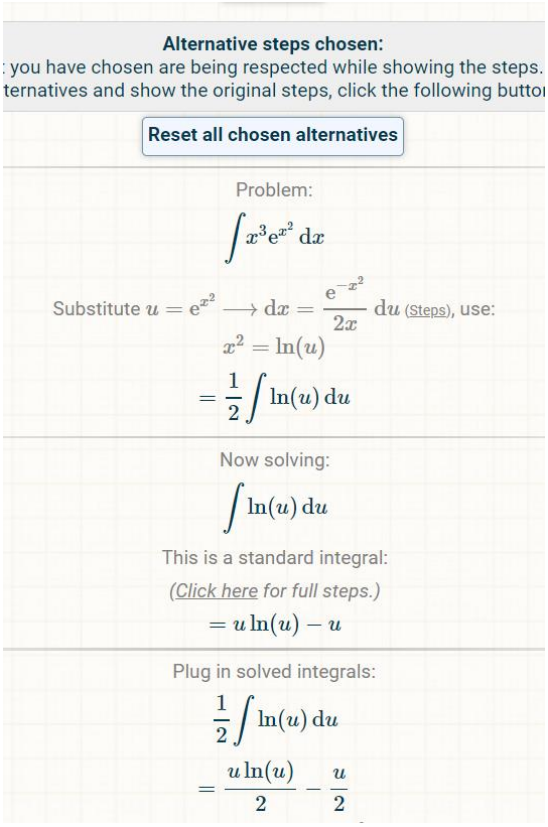

Figure 5.a. The alternative version of problem (5) by Integral Calculator online application

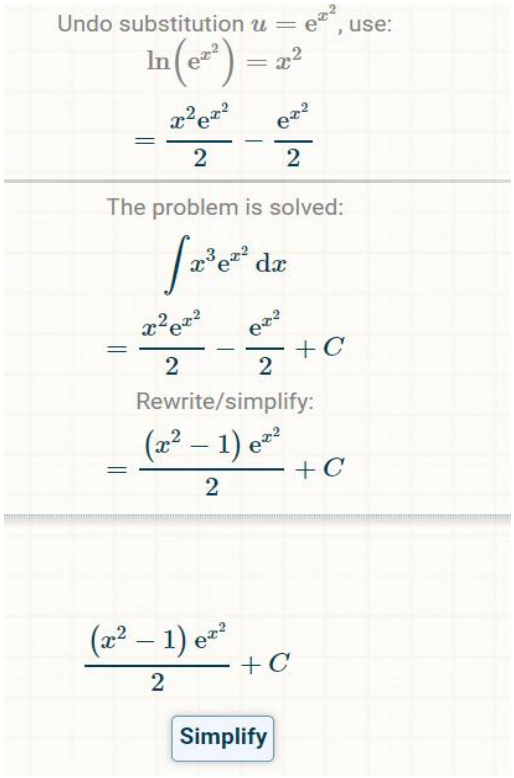

Figure 5.b. The alternative version of problem (5) by Integral Calculator online application

The alternative version by substitute e^{x^2} provoke confusion for students. Although the high level students also wondering where the $x^2 = \ln(u)$ come from when just have $u = e^{x^2}$ from this alternative version. This can be a weakness for the application since students understanding rely much on the steps. But this can be solved by just giving a clue about changing exponential function into logarithmic function by using the fact that $2^3 = 8\ so\ \ ^2\log 8 = 3$. From this clue, the student could find the reason why $u = e^{x^2}$ could be changed into $x^2 = \ln(u)$.

To sum up, the use of Integral Calculator online application to teach integration techniques cannot be done independently by students. They still need attendance of an expert. The expert is not always a teacher or lecturer. They can be their friend or senior who have more mathematical ability. In others hands, students could make a group discussion when practicing integration technique using this online application. Moreover, the use of Integral Calculator as a learning tool could be considered to cut the misuse of smartphone in classroom.

Teaching in era 4.0 should compromise with technology. Educator must find way to make students use technology wisely. There are many things we can search in internet so as students they have to know how to find it, how to choose the trusted one and how to utilize it. Make them independent learners but still controlled.

References

[1] Tindell D R and Bohlander R W 2012 The use and abuse of cell phones and text messaging in the classroom: A survey of college students *College Teaching* **60 (1)** 1-9
[2] Campbell S W 2006 Perceptions of mobile phones in college classrooms: Ringing, cheating, and classroom policies *Communication Education* **55** 280–294.
[3] Dodds R and C Y Mason 2005 Cellphones and PDA'shit K–6. *Education Digest* **70** 52
[4] Department of Education and Early Childhood Development 2012 *Blended learning A synthesis of research findings in Victorian education 2006-2011* (State of Victoria: Department of Education and Early Childhood Development) 2012
[5] Scherfgen D 2018 *Integral Calculator application* [Online] Available at https://www .integral-calculator.com/ (Accessed July August 2018)
[6] Tall D 1997 Functions and calculus *International Handbook of Mathematics Education* ed A J Bishop K Clements C Keitel and J Kilpatrick (Dordrecht: Kluwer) pp. 289-325
[7] Cheshier S R 2006 *The Field of Engineering Technology Studying Engineering Technology: A Blueprint for Success*
[8] Kent P and Noss R 2000 The visibility of models: using technology as a bridge between mathematics and engineering. *Int. J. of Mathematical Education in Science and Technology* **31(1)** 61-70
[9] Mahir N 2009 Conceptual and procedural performance of undergraduate students in integration *Int. J. of Mathematical Education in Science and Technology* **40 (2)** 201-11
[10] Salleh T S A and Zakaria E 2011 Integrating computer algebra system (CAS) into integral calculus teaching and learning at the university *Int. J. of Academic Research* **3 (3)** 397-401
[11] Walker D 2006 Toward Productive Design Studies: Why now? *Educational Design Research* ed J V Akker, K Gravemeijer, S McKenney and N Nieveen (London: Routledge-Taylor & Francis Group)
[12] Gravemeijer K and Cobb P 2006 Design research from the learning design perspective. *Educational Design Research* ed J V Akker, K Gravemeijer, S McKenney and N Nieveen (London: Routledge-Taylor & Francis Group)