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## The Use of iPad For Calculus Class in Higher Education: Notability Application

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### Abstract

Mobile devices have turned into attractive educational learning tools. While the majority of prior study has largely focused on the benefits of mobile learning for students, there is currently a paucity of study on the usage of educational applications available on the market. Hence, this study attempts to explore Notability, an educational digital tool available in the iOS app store. This study used descriptive analysis to describe the idea of Notability and the qualities it provides. This study discovered that using Notability in calculus classes at the tertiary level is effective and provides an active learning environment. Furthermore, Notability provided instructors with the ability to deliver content quickly and effectively, whether synchronous or asynchronously. In addition, the Notability capabilities enable educators to employ technology tools and facilitate paperless classrooms.

**Keywords:** Calculus, iPad, M-learning, Notability, Technology-based Learning

### Introduction

Nowadays, the use of technology has become so prominent. It is common to walk into a classroom at any level along with technological devices. Many traditional teaching tools such as whiteboards and marker pens have been replaced by modern technological devices, and curriculums are always revolving around online learning. Modern technologies and devices have been adapted into the younger generation's life, where they predict a fundamental change in the way young people communicate, socialize, create and learn (Helsper & Eynon, 2009). Today's students are no longer the people of our educational system that was designed to teach (Prensky, 2001b). Prensky (2001b) defined young generation as digital natives as they speak and understand of the digital language of technological devices and internet. Young people think and process information in fundamentally different ways compared to the older generation (Prensky, 2001b; Prensky, 2001c). Prensky (2001b) explained the characteristics of digital natives that are used to receiving information really fast. They like to perform parallel-processing and multi-

tasking. Moreover, technological devices are important to contribute in quality education as part of the United Nations marked Sustainable Development Goal 4 for the horizon 2030 (Velázquez & Méndez, 2018).

Since the emergence of iPad in 2010, there are relatively new forms of technologies that have entered the world of education in improving the experience of student learning. Many schools and universities mandate students to have their own personal iPad devices to access online learning tools, applications, and digital textbooks, both inside and outside of school, despite the lack of studies about its impact on teaching and learning (Jahnke & Kumar, 2014). Although iPad is still in its infancy stage with respect to educational purposes, iPad applications are expanding learning experiences both inside and outside of the classroom. The possibilities extend from new interactive textbooks to study aids, and from study aids to productivity tools, making its potential usefulness to educators become worth exploring for.

Unfortunately, along with this excitement, confusion and bewilderment may come among those teachers who feel submerged by the new technology. Based on Ertmer and Ottenbreit-Leftwich's (2010) findings, although educators have increased their personal and professional use of computers in general, instructional technologies in classrooms still tend to be low-level through lesson presentations using PowerPoint, searching the Web for information resources, as well as assigning homework using the computer.

The reason teachers are reluctant to incorporate technology into the classroom is that, with the tools and resources constantly changing and always being in a state of flux, teachers are in effect being asked to hit a moving target (Gary, 2012). Hence, they will never have a comprehensive and holistic knowledge of tools available, and this often results in some teachers remaining as everlasting beginners in the process of technology integration. According to Ejiwale (2013), lack of modern knowledge also is one of the barriers to successful implementation of science, technology, engineering and mathematics (STEM) education.

Therefore, to solve this issue, this study briefly explains the design and development of e-materials using Notability on iPad in calculus class at tertiary level. Besides, this study also presents both its advantages and disadvantages of classroom-based teaching and learning. This study focuses on teaching calculus in order to demonstrate that using Notability on the iPad is a better option for teachers rather than using whiteboard or PowerPoints. The primary issue can be easily solved by Notability, especially when writing the equations with a variety of mathematical symbols and drawing figures as well as graphs while taking advantage of the digital environment to zoom or scroll the images. Learning mathematics or calculus through PowerPoints is not so suitable as Asmar and Delyana (2020) found that students were not preferred that mathematics should be taught using PowerPoints. Meanwhile, according to Wilson and Maclaren (2013), using PowerPoints can become a constraint while, pen-enabled Tablet PCs is the better approach in teaching mathematics as it allows to write, draw and sketch just like in whiteboard but in vivid colour.





### **Notability App**

Notability is one of the most popular apps in the App Store in the category of productivity and specifically for note-taking. This versatile note-taking app can be used anywhere whether in school, home or office. Rumerich and Kecskemety (2019) found in their study that 77.5% among








First Year Engineering students use Notability app for note-taking. The app allows user to type or write notes and also organise all the notes accordingly in folders inside the app. For teachers, it can also annotate PDFs, which is great for grading student papers. Notability also records audio and allows note-taking at the same time. So, reading conference with a student, or testing their reading fluency with the audio recorder while taking notes at the same time on iPad is possible. Even though users can use the Notability alone with fingers, but it is best to use with Apple Pencil when it is used on the latest version of an iPad, iPad Pro, iPad Mini or iPad Air. This feature can be useful for students for writing notes in lectures or sketching objects when on a field trip (Rumreich and Kecskemeti, 2019). The ability of the app to retrieve, annotate and submit work in one app gives so much freedom of the workflows for teachers and students. In addition, Notability integrates several cloud storages such as Dropbox, Google Drive, OneDrive and Box cloud (Eustis, 2015). If teachers set up a shared folder with their class via Google Drive, students can access their documents, annotate them, and reupload them back to their teacher via a privately shared folder. Vice versa with the teachers, where teachers can import the students' works, annotate and export all the documents into the cloud. All these processes can be done in Notability without hassle. Notability can be used in many ways depending on the users profile either teachers or students.

### Notability Function

There are several tools provided in Notability which help educators in the teaching process. Therefore, the functions of each tool in the interface are explained in the table below.


Symbol	Tool Name	Function
	<b>Type</b>	This icon represents the typing function. Once tapped, the user can click anywhere on the active document to begin working. For the perceived ease of use, the app's keyboard has its own toolbar that can be customised. Tapping and holding a finger on the toolbar also allows the user to make modifications.
	<b>Pencil</b>	This icon is used for freehand-writing and drawing. This is one of the best tools compared to those in similar apps available in the market. Writing with finger or Apple pen in Notability does an excellent job of capturing handwriting naturally and gives each document a personalised look.
	<b>Highlighter</b>	This tool can be used on anything on the documents including pictures, web pages, writing, drawing as well as texts. The user can change the pen by simply clicking the highlighter tool and select different colour, style, or size.
	<b>Eraser</b>	The Eraser tool is available in most common apps. However, this Notability's tool is a bit of a hindrance. The eraser can often be overly helpful as it will erase all lines connected to the portion touched. This is a major drawback as a user can spend time creating a detailed document only to have a wayward swipe that removes a large portion. Fortunately, the eraser tool does not work on text that has been typed,

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		and the text must be erased with the backspace key. The undo and redo tools often come in handy in these cases but, the redo feature is hidden and can only accessed by pressing down the undo icon.
	<b>Scissor</b>	This tool is very useful for a user to quickly cut out a section of writing or drawing information between pages or notes. This tool allows the user to change the style like thickness and colour, duplicate, cut, copy, convert to text, and delete the selected note or drawing.
	<b>Hand</b>	While writing notes, the user has to use this tool to scroll up and down. Otherwise, the Apple Pencil will leave marks on the notes if the user is still using the Pencil tool or the Highlighter tool to scroll. However, for a quick action, the user can also use one finger to scroll the note. Notability will automatically identify finger as Hand tool while still using other tools.
	<b>Undo</b>	Undo tool is a common tool that is available in any productive applications like Microsoft Word, Google Docs, Adobe Photoshop and others. The function is also similar, which is undoing the previous action. Users can use this tool to quickly undo without having to change to other tools like Eraser or Scissor tools.
	<b>Export</b>	After the user completes the editing of a document, the user has multiple choices to export the work. The documents can be sent through e-mail, social media or moved into cloud storage.
	<b>Record</b>	This icon will begin recording so the user is able to record a lecture while taking notes, or voiceover an original document. Recording can be continuous or paused and restarted to create multiple files. The loop icon on the audio means calling up a list of recordings, and each audio file can be shared separately or exported entirely with the document. The volume of the recording can also be adjusted, and there are advanced features for audio tuning to adjust frequency and speakers.
	<b>Media</b>	This tool allows the user to insert a variety of photos, notes, and clips into a document. The Photo option allows the user to pull existing images from the camera roll or take a new photo with the iPad camera. The add Figure option allows the user to freehand draw or select a variety of shapes to create custom images. In addition, the user can also crop an image or annotate a photo. There is an undo button on the editing screen but there is no redo button. So, the user should take caution during the editing.
	<b>Options</b>	The user can select a few options like paper types, view settings, info and help. In Paper option, user able to choose the paper to be in colour, pattern, lines, grids or dots. Also, user can also select the combinations of blue and grid paper for example. In View option, the user can choose to view the note in seamless view, which allows the note to be scrolled vertically in an endless canvas, or in a single page view, which allows flipping the note page by page, horizontally. The third option is Info. It

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	shows the details of the note such as date and word count. Finally, the Help option will bring the user to the support page on the developer's website which is <a href="http://www.gingerlabs.com">http://www.gingerlabs.com</a>
	<b>Page navigator</b> Page navigator allows the user to navigate the notes quickly at a glance, without having to scroll the them entirely. The user can also navigate to bookmarked pages of the notes. For a quicker action, the user can search for keywords, regardless whether the notes were written with Type tool or Pencil tool.

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### **Employing Notability in Calculus Class**

Employing technologies in teaching and learning needs several pedagogical elements to assist students to learn better and faster, and help make the lecturer's time to be utilised more effectively. Therefore, this study highlights three crucial elements that need to be taken into account, to digitalise classrooms.

### **Learning Objective**

Calculus I am the first course in the calculus series. In order to prepare the students to move to the next phase of calculus series, Calculus I need to be mastered first. In Calculus I, the students will learn about functions and graphs, limits and continuity, and techniques of differentiation and integration and its applications. The objectives of Calculus I are to ensure the application of the properties of function, limit and continuity, and techniques of differentiation and integration. The students must also be able to analyse appropriate graph of polynomial or rational function in solving related mathematical problems using calculus.

### **Learning Content**

The researchers ensure that the contents are well-designed and organized to achieve the learning objectives. Based on the analysis requirement study, the learning content must be covered by all topics in the course outline. The contents are organized from easy to hard and from simple to complex. The main purpose is to ensure content-relevance and develop students' confidence and satisfaction throughout the learning process.

### **Instructional Strategies and Delivery**

Notability allows teachers to write on iPad using the Apple Pencil. Teaching Calculus I requires many equations to be written with various kinds of mathematical symbols. It is very hard to for teachers to use a computer and write equations during class sessions. Hence, to replace the traditional whiteboard, Notability comes in handy. Notability can be used during and outside the classroom. There are few ways to use Notability for teaching and learning. However, in this study, the focus is on teachers' views.

### **Notability as Whiteboard**

Young generations today do not fit well with the current educational practice because they have their own unique preferences, tools and ways of interpreting information (Helsper & Eynon, 2009). Therefore, the current pedagogies employed in education need to transform to suit the



current needs of the digital natives. Teachers can no longer use old-style pedagogies to suit their needs. Therefore, teachers now need to communicate in a way that fits the digital natives' needs (Prensky, 2001). By using technology, teaching can also be delivered efficiently. Ginger Labs Inc. has developed a flexible, interactive and comprehensive application named Notability. Notability can enhance teachers' pedagogy and replace the use of whiteboard. By connecting their iPads to the projectors, teachers can deliver their lessons by simply writing on Notability. They can use the app as a blank whiteboard, or they can also project their PDF files on screen to annotate their notes. With this method, teachers will save a lot of time without having to rewrite their notes on the whiteboard. Students will be more focused on their teachers and produced better learning outcome (Wilson and Maclaren, 2013). When the iPad is connected to a projector, Notability will detect that connection and it will be automatically switched into presentation mode, as shown in Fig. 1. The presentation mode will only project the whiteboard in full screen, without any toolbars and menus. Also, an extra tool will appear - the Laser Pointer tool, as an option for the teachers to point their notes. All of this can be done without having to lift fingers off the iPad. Besides, teachers can share the notes that they have written in class to their students via email, Whatsapp, Telegram or upload them into Google Classroom. This app brings so much flexibility to teachers and students.

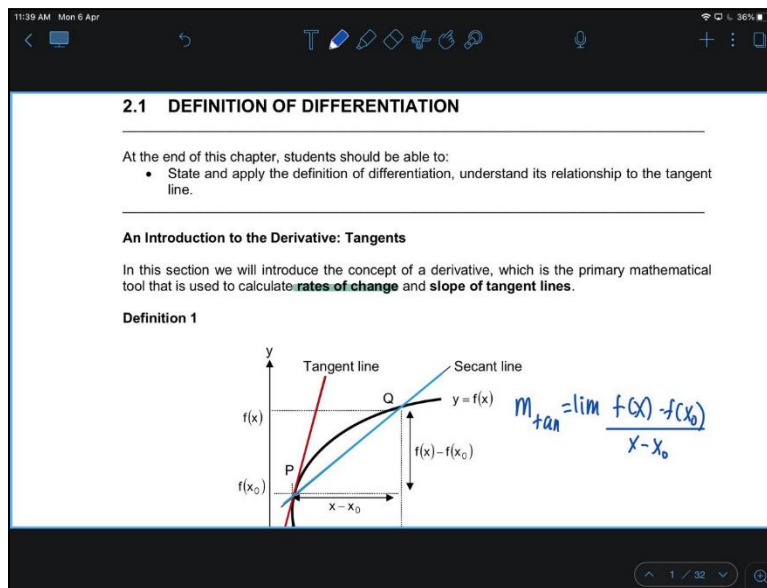


Fig. 1: In presentation mode, only the note will be projected on screen

### Preparing Continuous Learning Materials

For some students, class-learning alone is insufficient. They may require additional information after class. Hence, teachers can make their teaching materials available online, like sharing their extra notes, exercises, and lecture videos using various platforms. Preparing notes and exercises can be done on another platform like Microsoft Office. Different with Notability, teachers can record video lessons by writing and screen recording their iPads. Learning calculus is tough when teaching is only dependent on slides or textbooks, because detailed explanations are necessary. During screen recording, teachers can show problem-solving steps and methods along with

explanations with both audio and visual aids. An iPad can perform screen recording using its built-in screen recording function, which records both screen activities and speech. After the recording is complete, teachers can share their videos with the students.

### Marking Students' Assessments

The internet allows students to submit their assignments online. Teachers can download the assignments and mark them at once, using Notability. Both conventional ways of marking and commenting the students' papers can be done digitally. The app can read PDF files and the annotated version can be pushed back to the students, once marking is completed. An example of marking one of the students' assignments is shown in Fig.2.

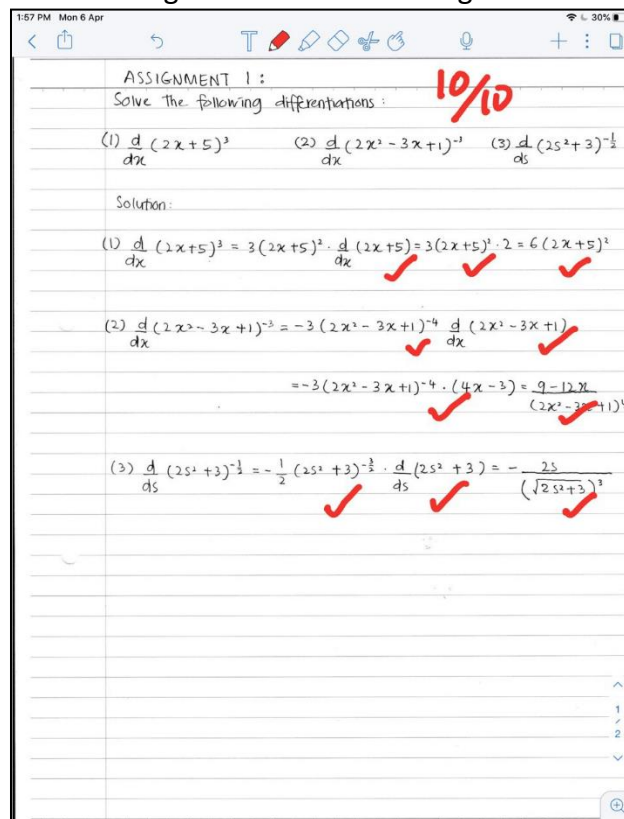


Fig. 2: Marking students' assignments

### Advantages and Disadvantages of Notability

There are masses of applications available on the App Store that teachers can use. However, applications that are perfect for everyone could be uncommon. In this section, the advantages and disadvantages of Notability is discussed.

#### Advantages

Compared to laptops or computer, iPad is more portable, has high quality touch interface, has simpler apps and loads faster (Haßler et al., 2015). Teachers can enter the class along with the iPad since Notability and the notes are already available there. This gives flexibility to the teachers to deliver their lessons efficiently and leading to faster learning curves (Haßler et al., 2015). The



iPad can be connected to a projector to replace a whiteboard and Notability will automatically switch the app to Presentation Mode. Hence, teachers are able to show their notes in full screen, and use the Laser Pointer tool to keep their students' attention. Based on researcher observation, Notability is very user friendly - the interface is straightforward and the icons are self-explanatory. Moreover, there is a Help button that will redirect the user to the developer's website for support. As a backup, the app can automatically sync the documents into available cloud storages such as Dropbox, Google Drive, OneDrive, Box and others, when the Auto-Backup function is turned on (Eustis, 2015). Notability is also available for MacOS version. Teachers can access their files and documents through their computers instantly. Furthermore, the notes can be shared in PDF and image formats to the students. So, these formats are great for sharing with students, on any platforms, applications or devices.

### **Disadvantages**

The only drawback of this method is the cost. Until 2020, Apple has released many versions of iPad and the price is getting more expensive to keep up with the latest version (Culen and Gasparini, 2012). Based on researcher observation, to write efficiently on Notability, the stylus - Apple Pencil, is highly recommended. This item costs an additional amount from the iPad, since it is sold separately. As a cheaper option, Logitech Crayon can also be used to replace the Apple Pencil. Also, for education purpose, Apple offers a discount for students and teachers to buy their products (Apple, 2020). As a matter of fact, Notability has no trial or free version. The app can only be purchased at USD9.99, but the price is for lifetime-use. However, the app sometimes is offered at a good price with a discount (Eustis, 2015). Since iPad is lack of VGA or HDI display port (Culen and Gasparini, 2012), extra tools or accessories are needed for projector's connection for example, the lightning dock to connect the iPad to the projector. Alternatively, Miracast can also be used to connect wirelessly to the projector.

### **Notability Contribution to Tertiary Education**

Teachers and students have to adapt to the advancement of technology in education. The lift of technology contributes a lot of positivity in terms of efficiency especially in tertiary education. In this section, the contributions of Notability apps in tertiary education are discussed.

### **Student Reading and Feedback**

Notability has a feature to record audio and handwriting in real time, that also available in other similar apps such as Educreations and Show Me (Williamson-Leadley & Ingram, 2013). Notability has a significant impact when working with numbers and equations. Teachers can import a copy of student's work into Notability, and then use the built-in microphone for audio recording purpose as to comment while annotating and explaining. Teachers can build an extremely valuable document to share with the students or for the teachers' reflections (Williamson-Leadley & Ingram, 2013) to write equations with stylus or finger easily while it is difficult to write equations with keyboard on the students' works. So, the students can get feedback from teachers quickly.

### **Paperless Classroom**

It is borderline impossible to use zero paper in classrooms, but an application like Notability makes life much easier since notes become searchable, secured and stored in a structured format. This app enables all documents to be saved into cloud storages like Google Drive, Dropbox or OneDrive, and then use Notability to mark up, annotate and append the notes and also to store students' results (Williamson-Leadley & Ingram, 2013).

### **Marking and Reporting**

Since Notability is integrable into cloud services, sharing and collaborating documents become simple and traceable. Notability solves corrupt memory issues and wrong email submissions. This app allows teachers to provide feedbacks directly into the document, and provide opportunities for both teachers and students to access the files again in the future.

### **Conference and Meeting Notepad**

Notability is used in popular venues like lecture theatres, meeting rooms and conference halls. Designed for mobile note taking, Notability is perfect to jot down thoughts, information, questions and equations quickly as teachers are giving their lectures (Rumreich and Kecskemety, 2019). Notability can record audio while the user writes notes. In regard, as the user replays the audio, Notability will highlight each note taken and sync it with the audio, which captures thoughts or ideas during a lecture or discussion, in a clearer manner. Furthermore, students can creatively write or draw their notes by using the provided tools inside the app (Rumreich and Kecskemety, 2019). This will give an impact on the notes and indirectly contributes to their understanding on the subjects.

### **Conclusion**

Teaching calculus requires flexibility, particularly in writing Mathematical equations with many symbols and special characters. Writing Mathematical equations with a keyboard alone is highly inconvenient, whereas whiteboard-scribbling is much easier. However, the limited space to write on a whiteboard makes iPad a better choice. Simply by holding an Apple Pencil, teachers can write notes using different colour options available on the app. Most importantly, Notability allows lessons to be carried out effortlessly, and more efficiently.

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