

## **Enhancement of Teaching Policy by means of Technology**

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**Abstract** In this paper the presenter will reflect on the use of a Tablet PC-based system used in the presentation of an Introductory Calculus module at undergraduate level. The focus will be on the role that various computer software packages and accessories played in the planning, design, implementation and assessment of this course.

### **1. Introduction**

A lecture presentation system called **Classroom Presenter** in which the instructor uses a **Tablet PC** as a presentation device was developed by the Computer Science Department of the University of Washington.[1,2,3] The key features of Classroom Presenter are described by Anderson, R et al. [4]. The problem that motivated the Classroom Presenter software was “How to improve the ability of an instructor to present lecture material from a computer.” The author sees Teaching Policy as a spectrum of actions like planning, design, lecture presentation, tutorials, assessment and feedback (List incomplete). In section 2 of this paper a brief summary of the lecture/learning material will be given. In section 3 the focus will be on the computer software packages and accessories utilized. In section 4 the focus will be on the design of a Polar Curve Template which was utilized as a Teaching Tool in the teaching of the lecture/learning material [5]. In section 5 to 9 various aspects of the lecture/learning material will be discussed and in section 10 critical support to student are briefly indicated.

### **2. Learning Material**

Various calculus related topics were addressed in the presentation of this module but in this paper the focus will only be on Polar Coordinates and Polar Curves. At the end of these lecture presentations it was expected that students should be able to:

- Explain the terminology connected to Polar Coordinates;
- Plot polar points if polar coordinates were given;
- Illustrate that in a polar coordinate system each point has many representations;
- Use the connection between Polar and Cartesian coordinates in conversions;
- Use the “plot-points” strategy to sketch polar curves;
- Use the “convert Polar equation to Cartesian equation” strategy to sketch polar curves;
- Use the “Deduce polar curve from Cartesian curve” strategy to sketch polar curves;
- Utilization of a graphing device in sketching of complex polar curves.

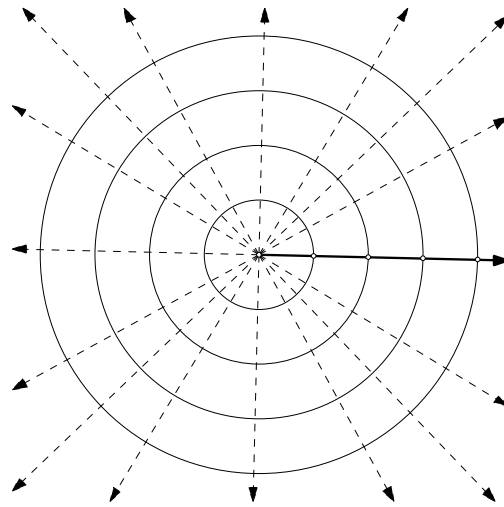
### **3. Software packages and accessories**

Effective lecture/learning material depended to a large extent on the design of quality **Power Point** slides. In the preparation of a **Classroom Presenter** slide a Power Point slide is saved by means of **Deck Builder** as a CSD-file from where it is imported to Classroom Presenter. In the design of a Power Point slide packages like **Geometer Sketchpad**, **Math Type**, **Autograph** together with the **Snipping Tool** as special copy and paste device were extensively utilized.

### **4. Polar Curve Template**

Geometer Sketchpad was used in the design of a Polar Curve template. Although a similar template is available in Autograph the designed template (See figure 1) contained essential details which are not emphasized in the Autograph template. In the designed template the polar

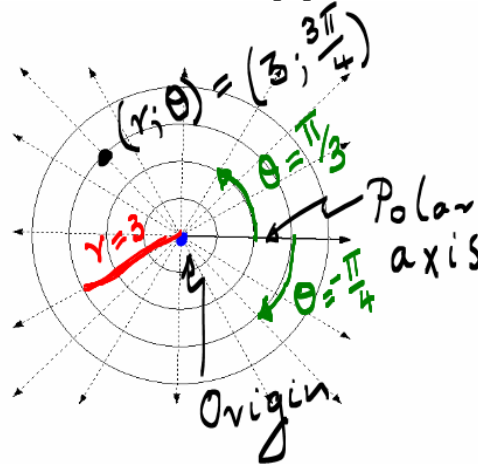
axis as well as scales for the relevant argument (angle) and modulus (distance) characteristics were included.



**Figure 1: Polar Curve Template**

## 5 Terminology connected to Polar Coordinates

A Classroom Presenter slide of this Polar Curve Template was used in illustrating visually the concepts of origin, polar axis and polar coordinates. Figure 2 illustrate the Polar Curve Template together with Classroom Presenter inking as utilized in a lecture. (Snipping Tool was used to import figure 2 from Classroom Presenter into this paper.)



**Figure 2: Classroom Presenter slide with inking**

## 6. Plot polar points

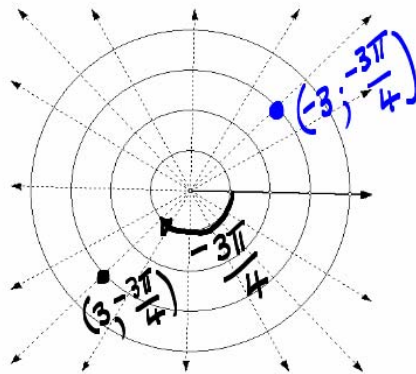
Classroom Presenter slide illustrated in figure 3 was utilized to facilitate this part of the lecture. In the plotting of the polar point in example 4 the lecture-actions/strategies and relevant inking are indicated in figure 3.

## 7. Conversion from Polar to Cartesian coordinates and vice versa

Conversion was facilitated by means of a Classroom Presenter slide illustrated in figure 4. During the lecture two different slides were used for the two types of conversions, but in figure 4 are indicated as a unit.

**Plot points if polar coordinates are given**

- 1)  $(1, \frac{5\pi}{4})$
- 2)  $(2, 3\pi)$
- 3)  $(2, -\frac{2\pi}{3})$
- 4)  $(-3, -\frac{3\pi}{4})$



- Math Type was used in the typing of the mathematics.
- Out of the four examples special attention was given to example 4, which is illustrated in figure 3.
- Multiple representations for the polar point  $(1, 5\pi/4)$  namely  $(1, 5\pi/4) = (1, -3\pi/4) = (-1, \pi/4)$  were demonstrated.

Figure 3: Plot polar points

**Conversions between Polar & Cartesian Coordinates**

$$\begin{cases} x = r \cos \theta \\ y = r \sin \theta \end{cases}$$

Convert  $(-2, -\frac{\pi}{3})$  to Cartesian coordinates

$$\begin{cases} r^2 = x^2 + y^2 \\ \tan \theta = \frac{y}{x} \end{cases}$$

Convert  $(1, -1)$  to Polar coordinates

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- The conversion from Polar Coordinates to Cartesian Coordinates is illustrated in figure 5 together with the minimize capacity of Classroom Presenter. (Slide is minimized to create more writing space).
- If not sufficient writing space is available the “Whiteboard” facility of Classroom Presenter, as illustrated in figure 6, can be utilized.

Figure 4: Conversion activity

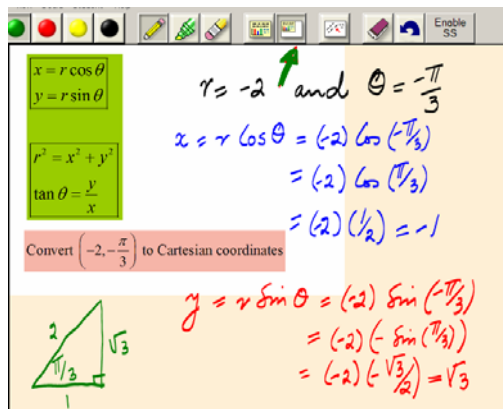


Figure 5: Minimize capacity

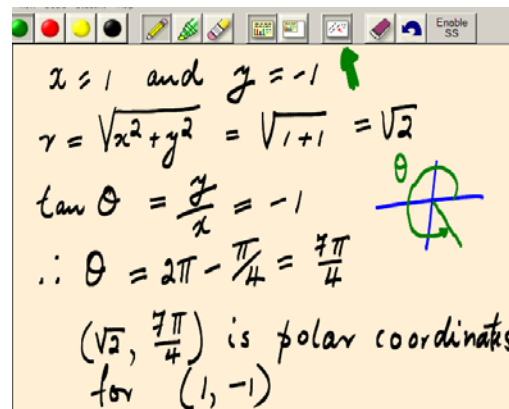
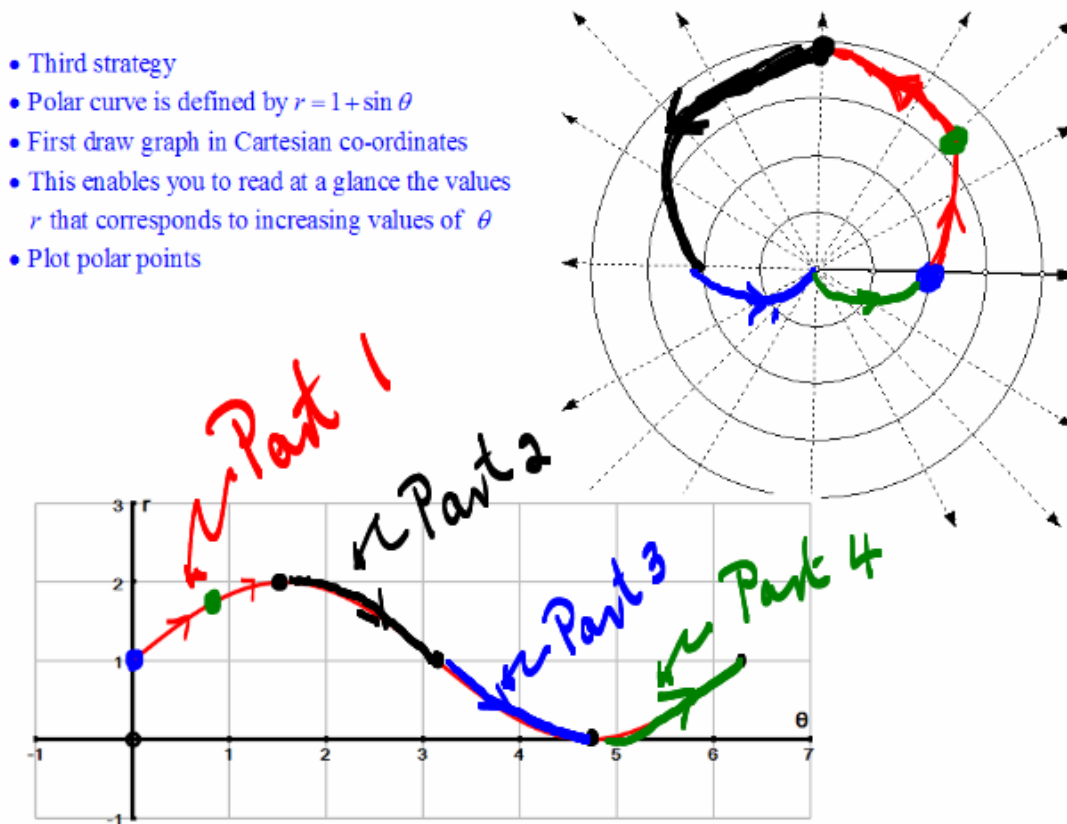


Figure 6: Whiteboard facility

### 8. Sketches of Polar Curves

Three strategies were used in this part of the lectures. Since the first two are well known but limited strategies, only the third strategy will be discussed in this paper. The first strategy was simply to determine a variety of points on the polar curve and then plot these points on the Polar Curve Template. As a second strategy the defining equation for the Polar curve was converted to a defining equation for the equivalent Cartesian curve which was then drawn on a Cartesian plane template (Strategy used in school mathematics curricula). As a third strategy the curve defined by means of a polar equation was first drawn as a curve in Cartesian coordinates on a Cartesian plane template which enables the learner to read of the corresponding polar coordinates at a glance and plot these on a Polar Curve Template.

Example of such an activity is illustrated in figure 7 and the classroom implementation thereof is highlighted by appropriate inking.



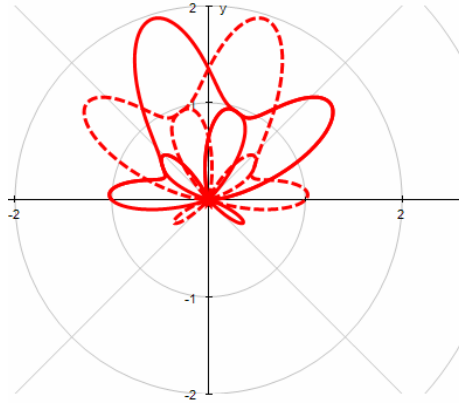
**Figure 7: From Cartesian to Polar Curve**

The use of color in the design and implementation of Classroom Presenter slides as a natural aid is highly recommended.

### 9. Overcoming limitations posed by hand-drawn graph techniques

Students soon realized that some polar curves cannot be constructed or are not easily constructed by using the three indicated strategies. Thus the need for incorporating a graphing device like Autograph needs to be demonstrated in conclusion to such a series of lectures (Autograph was used extensively throughout this lecture series and not just at the end). Students can then, if available, practice this graphing technique in the Mathematics and Applied Mathematics

Computer Laboratory. An example of a polar curve sketch drawn by means of Autograph is illustrated in figure 8.



**Figure 8: Polar Curve for  $r = \sin \theta + \sin^3(5\theta/2)$**

## 10. Critical support

All Classroom Presenter slides in PDF-format are made available to students on the NMMU Intranet which enables students to relive the lecture afterwards at their own pace. They could also discuss problems that they might have experienced during a lecture with the lecturer or teaching assistant (At NMMU we have a support system where a senior mathematics student is conducting supplementary instruction sessions on a weekly basis). In a similar way copies together with suggested solutions to tutorials and tests are made available to the students on the Intranet. In the same way guidelines, not in fine detail, to suggested solutions for exercises from their text-book and clearly indicated in their Study Guides are posted on a regular basis on the Intranet.

## 11. Conclusion

Feedback from students indicated that they have great appreciation for, and derived real benefits from the Classroom Presenter based teaching model. From a personal point of view I honestly can say that I will teach in no other way in the future. I can only but agree with Anderson et al when they conclude “We expect Tablet PC-based presentations will become widespread, and the affordance of electronic ink integrated with slides will have a major impact on the university lectures in the future”.

## 12. References

- [1] <http://www.cs.washington.edu/masters>
- [2] <http://www.cs.washington.edu/education/dl/tools/>
- [3] <http://www.cs.washington.edu/education/dl/confxp/wmgateway.html>
- [4] <http://www.cs.washington.edu/education/dl/presenter/papers.html>. Anderson, R., Anderson, R., Hoyer, C., Simon, B., Videon, F., Wolfman, S. (2003). Lecture Presentation from the Tablet PC. Workshop: Advanced Collaboration Environments.
- [5] Boshoff, H.H. (2005). Polar coordinates and curves. Unpublished lecture notes available as Power Point slides in PDF-file format.