

# Visualizing the changes in cytotechnology students' performance in evaluating digital images

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## ABSTRACT

**Background:** The objective of this study was to analyze the locator and interpretation skills of cytotechnology (CT) students using an eye tracking device and static digital images with regard to the: number of fixation points, task duration, and gaze observations in regions of interests.

**Methods:** Static digital images (DI) of gynecologic cytology specimens were serially displayed on a computer monitor for evaluation by CT students. During evaluation, students' eye movements were monitored with a Mirametrix S2 eye tracker and EyeWorks™ software. Over the two academic year periods (2016-2017, and 2017-2018), two consecutive sets of students completed the protocol at 3 different time periods during their one-year training: Period1 (P1) - 4 months, Period2 (P2) - 7 months, Period3 (P3) - 11 months.

**Results:** For the three students who participated in the study during the year, 2016-2017, the mean number of fixation points on DI significantly decreased at P3 when compared to P2 (81.0 vs. 58.9,  $p=0.006$ ); mean task duration significantly decreased from P1 at both P2 (42.5 vs. 36.0,  $p=0.03$ ) and P3 (42.5 vs. 26.6,  $p<0.0001$ ); and mean gaze observations were significantly lower at P3 when compared to P1 (201.6 vs. 112.5,  $p=0.042$ ). For the eight students who participated in the study during the year, 2017-2018, there was a statistically significant difference in the: mean number of fixation points between the two assessment periods (P1 was 44.16 vs. 27.16 for P3,  $p=0.0002$ ), and mean duration between the two assessment periods (P1 was 37.89 vs 26.91 for P3,  $p<0.0001$ ).

**Conclusions:** These results were consistent with more efficient performance by CT students when evaluating DI later in the training program. Our study demonstrated the potential of eye tracking methods in visualizing changes in student performance while achieving mastery of cytopathology interpretation. Eye-tracking methods could also offer a means of providing rapid student feedback and tutoring.

## Background

The visualization of the digital images (DI) by the pathology residents and medical students has been investigated using eye-tracking system and found that tracking the visualization of DI has the potential for use in training and assessment.<sup>1,2</sup> However, eye tracking technology has not yet been investigated in cytotechnology (CT).

The objective of this study was to analyze the locator and interpretation skills of CT students using an eye tracking device and static digital images with regard to the: number of fixation points, task duration, and gaze observations in regions of interest.

## Materials and Methods

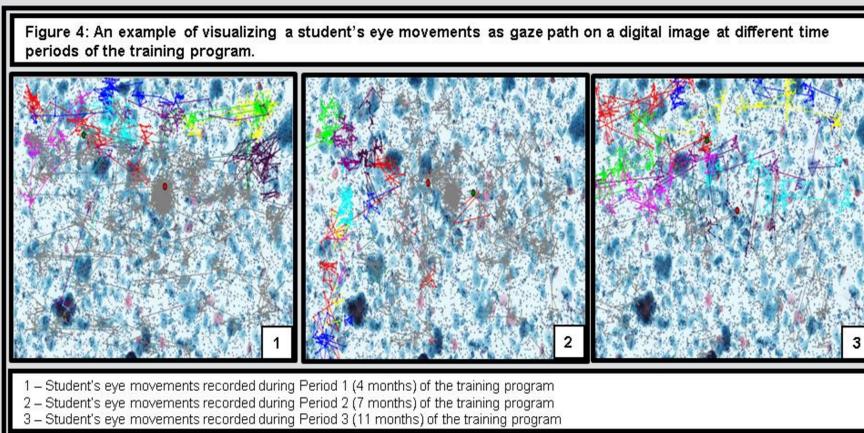
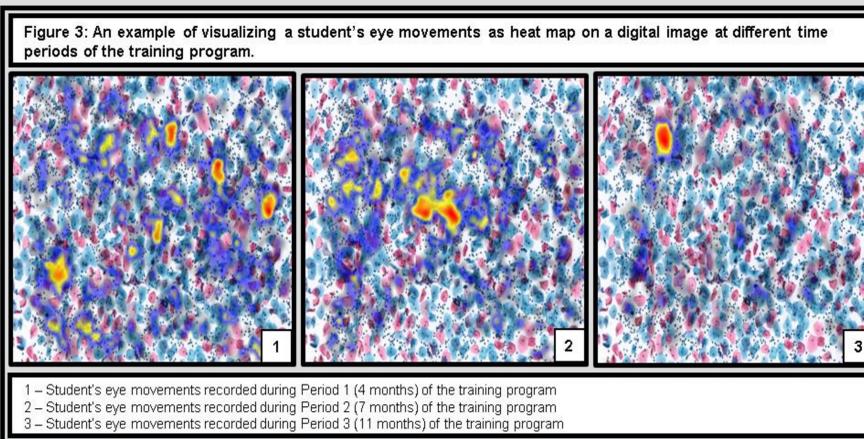
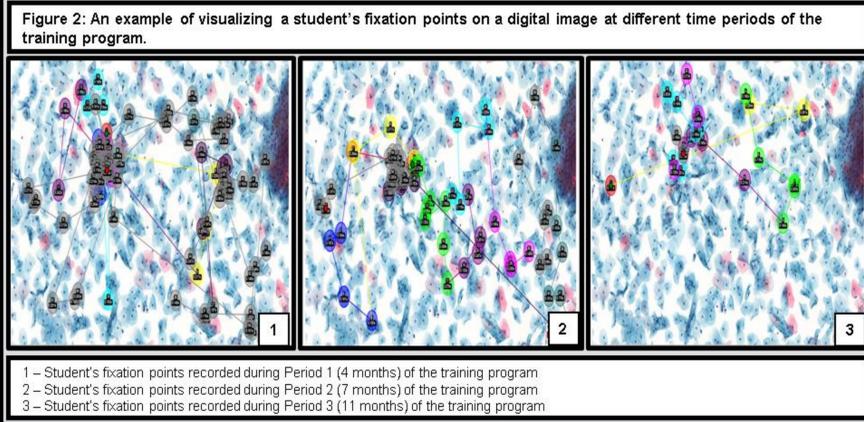
During the year 2016-2017, 25 Static DI of gynecologic cytology specimens were serially displayed on a computer monitor for evaluation by 3 students at the CT program at the University of Nebraska Medical Center. During evaluation, students' eye movements were monitored with a Mirametrix S2 eye tracker and EyeWorks™ software (Figure 1). Students completed the protocol at 3 different time periods during their one-year training: Period1 (P1) - 4 months, Period2 (P2) - 7 months, Period3 (P3) - 11 months.



Figure 1: Eye movements on the static digital image displayed on a monitor with Mirametrix S2 eye tracker and EyeWorks™ software being recorded.

A similar protocol was repeated the following year, 2017-2018 with 8 students from UNMC (both from campus and distance site), and Magee-Women's Hospital of University of Pittsburgh Medical Center, Pittsburgh. A general linear mixed model was used to analyze number of fixation points, task duration, and gaze observations in regions of interests.

## Results



	Period 1	Period 2	Period 3
Number of fixation points	75	81	59
Task duration	43	36	27

Table 1: This table shows the adjusted mean number of fixation points and task duration of three students recorded on the gynecological digital images over the three time periods of the one-year training (2016-2017).

	Period 1	Period 3
Number of fixation points	44	27
Task duration	38	27

Table 2: The table shows the adjusted mean number of fixation points and task duration of three students recorded on the gynecological digital images over the two time periods of the one-year training (2017-2018).

## Discussion

The objective of this study was to analyze the locator and interpretation skills of CT students using an eye tracking device and static DI.

As the results (Tables 1 and 2) indicated, for the students who participated in the study during the year, 2016-2017, the mean number of fixation points on DI significantly decreased at Period 3 when compared to Period 2, and mean gaze observations were significantly lower at Period 3 when compared to Period 1. For the students who participated in the study during the year, 2017-2018, there was a statistically significant difference in the: mean number of fixation points between the two assessment periods, and mean duration between the two assessment periods.

We faced a few technical difficulties that resulted in failure of data recording. For that reason, even though 13 students participated in the year 2017-2018, the data of five students had to be disregarded in the statistical analysis. In addition, we did not include the data collected at period 2 of the year 2017-2018. This study however, was helpful in demonstrating the enhanced performance in evaluating DI by CT students towards the end of their training program.

## Conclusions and Future Directions

In conclusion, our study demonstrated the potential of eye tracking methods in visualizing changes in student performance while achieving mastery of cytopathology interpretation.

Eye-tracking methods could also offer a means of providing rapid student feedback and tutoring. With these results, we aim to analyze the screening skills of our CT students using digitized whole slide images in the future.

## References

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