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# Basketball, Algebra, and Probabilities

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## Synopsis

This article is an attempt to illustrate some humanistic aspects of mathematics in context, in particular, sports and scoring (basketball). The intriguing and dynamic illustrations demonstrate innovative and creative ways of integrating basketball snapshots into the pedagogy of a high school or college-level mathematics-in-context course. I have used this activity with several mathematics education students in a mathematics-in-context class as they worked in groups of five. I include here a presentation and a discussion of their explorations and analyses.

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## 1. Introduction

Have you ever looked through the charts and graphs of a basketball game while the game is still ongoing or at the end of the game? Analyzing such graphs and data during a basketball game could be an inspiring learning activity for students of a mathematics-in-context class. Being a huge basketball fan (NBA, World Cup, EuroBasket, etc.) for many years, I was always very much attracted to the statistical data and graphs summarizing each team's score development along with individual players' contribution to the game in a variety of ways (2-point scoring, 3-point scoring, fouls committed, turnovers, etc.). Curious about how my students would interpret such snapshots of basketball games, I implemented this activity with a group of twenty mathematics education students in a mathematics-in-context course. The article highlights their discoveries and interpretations of the mathematical ideas pertaining to such basketball score development snapshots. I conclude with some reflections as well as a few more mathematical ideas.

## 2. A Basketball Snapshots Activity

In groups of five, my students analyzed a series of snapshots pertaining to four different basketball games from EuroBasket 2013, all taken from the <http://www.fiba.com> website. Each group highlighted their interpretations and discoveries of the mathematical ideas that might be revealed by these snapshots. Below I outline students' analysis and the mathematical connections they highlighted for each of the four games.

### Game 1: Italy 58–66 Ukraine [EuroBasket 2013, September 20, 2013]

The students of Group 1 discussed six snapshots from the Italy-Ukraine game in details and came up with very creative and original mathematical ideas that could be connected to this basketball game. This group seemed to have focused more on the algebra connections.



Snapshot 1: Italy-Ukraine Score Development Chart [Final].

In this group, S1<sup>1</sup> viewed the score development chart (Snapshot 1) as “a line graph based on time and score: the variables for the line graph.” S2 interpreted Snapshot 1 as a “linear equation that shows the relationship between time and score.” S3 also pointed to the variables of time and score in her own way: “x/y axis gives you two different items to compare.”

S4’s analysis based on Snapshots 2 and 3 were more detailed and included more mathematical connections: “point difference in line graphs shows the distance in the scoring of both teams as a specific time in the graph.” Finally, S5 pointed to the fact that the intersecting lines would refer to a draw situation [Snapshot 2]; and that the long white horizontal line segment [Segment 3] would indicate that Italy failed to score for about five minutes: “Italy stayed at a constant point of 48 points while Ukraine kept increasing further into 35 minutes.”



**Snapshot 2:** Italy-Ukraine Score Development Chart [Score: 30-30].

<sup>1</sup>I chose to label students as S1, S2, S3, and so on, in order to avoid any cultural or gender-based assumptions that may bias the reception of their comments.



**Snapshot 3:** Italy-Ukraine Score Development Chart [Score: 48-59].

**Game 2: Lithuania 77–62 Croatia** [*EuroBasket 2013, September 20, 2013*]

The students of Group 2 seemed to focus more on probabilistic, rather than algebraic, aspects of the game they were assigned to: the Lithuania-Croatia game on September 20, 2013 [Snapshot 4]. S6, for instance, stated that “Lithuania don’t have a good shooting percentage... they are shooting 27 of 64, which is less than half.” S7 said “if you weren’t to look at the score, you would have assumed Croatia won.” S8 compared the two teams’ 3-point scoring: “Lithuania had a better shooting percentage at the 3-point line.” S9’s analysis was based on the teams’ score development in each quarter: “Both teams had 2 quarters with higher points: Lithuania led Quarter 1 (24-19) and Quarter 3 (21-8) while Croatia led Quarter 2 (18-16) and Quarter 4 (17-16).” Finally, S10 came up with a very interesting and original statistical analysis, which depended on the following point: “Croatia has more fouls which could have contributed to Lithuania’s win since they had more opportunities for shooting fouls.”



**Snapshot 4:** Lithuania-Croatia Team Stats Comparison.

**Game 3: Spain 92–66 Croatia** [*EuroBasket 2013, September 22, 2013*]

Group 3 was assigned the September 22 game between Spain and Croatia. While Group 1 students seemed to focus more on the algebra aspects, and Group 2 students focused more on the statistical aspects, Group 3 students appeared to have focused on both aspects in an equal manner. S11, for instance, emphasized the x and y-axes: “the snapshot [Snapshot 5] uses x and y variables when graphing the linear graph, while the linear graph itself shows the time compared to the score during the course of the game.” S12 stated: “there is a certain time both teams were in the lead and ended up tying for the first time shown on the graph.” One student, S13, in this group, emphasized the color-coded feature of the score development chart: “on the score development graph, the white line shows Spain’s team progress, while the green line shows the Croatia team’s progress.”

S14 interpreted the pie charts [Snapshot 6] as follows: “Shown by the pie chart both teams shooting percentage had a difference almost 4.5% difference and with that you will see who is winning because they were able to score more.” Finally, S15 interpreted Snapshot 6 as follows: “The snapshot uses

different bar graphs to display team stats. They compare and contrast things like how many fast break points a team had or how many points from turnover each team had.”



Snapshot 5: Spain-Croatia Score Development Chart [Final].



Snapshot 6: Spain-Croatia Team Stats Comparison.

**Game 4: Serbia 76–64 Italy** [*EuroBasket 2013, September 21, 2013*]

Group 4, assigned to the September 21 game between Serbia and Italy, also seemed to have focused more on the algebra connections. Having analyzed Snapshot 7, S16 interpreted the vertical line as indicating “the score at a specific time.” S17 interpreted Snapshot 8 as follows: “the lines never intersect which means that Serbia was always in the lead from the beginning to the end of the game.” S18 interpreted the dashed vertical line segment in Snapshot 8 as “the score difference at a specific time.”



**Snapshot 7:** Serbia-Italy Score Development Chart [Score: 30-11].



**Snapshot 8:** Serbia-Italy Score Development Chart [Final].

### 3. Reflections

In each group, students explored snapshots pertaining to each game within the seventy-five minutes of a mathematics-in-context class. Each group came up with very interesting and original mathematical connections as highlighted above. Had they been given more time to explore, students could have perhaps come up with more mathematical connections as well. This section outlines previously highlighted and additional possible mathematical connections pertaining to basketball snapshots illustrated above.

- On the score development graph, what is the significance of the yellow vertical line? (applicable to Snapshots 2, 3, 7, and 8).
- What does it mean for the “lines” to never intersect? How does it translate to what actually happened? (applicable to all snapshots except Snapshots 4 and 6).
- What does it mean for the “lines” to intersect? How does it translate to what actually happened? (applicable to all snapshots except Snapshots 4 and 6).
- On the score development graph, what is the significance of the white dashed vertical line segment? (applicable to Snapshots 2, 3, 7, and 8).
- On the score development graph, what is the significance of the horizontal line segments which seem to be longer than some others? (applicable to Snapshots 2, 3, 7, and 8).
- Serbia-Italy Game (Snapshots 7 and 8): After 22:45, does it appear like the lines are parallel? What could this mean?
- Overall slope? What does it mean? Can it be estimated? (applicable to all snapshots except Snapshots 4 and 6).
- How can we interpret a graph with multiple intersections? (applicable to all snapshots except Snapshots 4 and 6).
- How could the biggest scoring run could be calculated by referring to the horizontal line (e.g., Snapshot 3)?