

The Volleyball Problem

The organizers of the volleyball camp need a way to divide the campers into fair teams. They have decided to do this using information from try-out activities that will be given on the first day of the camp. They also may try to use comments from the girls' coaches. The table below shows a sample of the kind of information that will be gathered from the try-out activities. Your task is to write a letter to the organizers where you: (1) describe a procedure for using information like the kind that is given below to divide more than 200 players into teams that will be fair, and (2) show how your procedure works by using it to divide these 18 girls into three fair teams.

Data From Volleyball Tryouts

Name	Height of player	Vertical Leap in inches	40 Meter Dash in seconds	Number of serves successfully completed out of 10	Spike Results (Out of 5 attempts)
Gena	6'1"	20	6.21	8	D-R D-U Kill I-N Returned
Beth	5'2"	25	5.98	7	Kill Returned O-B D-R Kill
Jill	5'10"	24	6.44	8	O-B Returned Returned Kill I-N
Amy	5'10"	27	6.01	9	Kill Kill D-U Kill Returned
Ana	5'6"	25	6.95	10	O-B I-N Returned Returned D-R
Kate	5'8"	17	7.12	6	Kill D-U Kill Returned Kill
Rhoda	5'3"	21	6.34	5	O-B Kill I-N I-N D-R
Christi	5'5"	23	7.34	8	I-N Kill Kill Kill D-U
Andrea	5'5"	24	6.32	9	I-N O-B I-N O-B Returned
Nikki	5'7"	19	8.18	10	D-U Kill Kill O-B Returned
Kim	5'9"	23	6.75	7	D-R Kill Returned O-B Kill
Robin	5'8"	15	5.87	8	Kill Kill Kill D-U I-N
Edna	5'4"	21	6.72	8	Kill Returned O-B I-N D-R
Lori	5'7"	19	6.88	9	O-B I-N I-N Kill Returned
Tina	5'1"	24	6.27	6	D-U D-R D-R Kill O-B
Angie	5'10"	23	6.54	8	O-B Kill O-B O-B D-R
Ruth	5'3"	26	7.01	9	D-U I-N Kill Kill Kill
Becca	5'9"	18	6.78	10	I-N O-B Kill D-R Kill

Volleyball Coach's Comments

<p>Gena: Gertrude is tall but slow getting to the ball.</p> <p>Beth: She is very agile on her feet.</p> <p>Jill: Jill's height and jumping ability should prove to be an asset for any team.</p> <p>Amy: She is an awesome leaper, but she needs to know when to use it.</p> <p>Ana: She's not very aggressive partly because she's only played on unsuccessful teams.</p> <p>Kate: Kate has great quickness to get to the ball after serves.</p> <p>Rhoda: Rhonda has a tendency to loaf – playing best when the team is playing well.</p> <p>Christi: She hides her abilities. Her family life has negatively impacted her ability to play well.</p> <p>Andrea: She is exceptionally strong for her age.</p> <p>Nikki: She does many things well. In particular she serves well.</p>	<p>Kim: Kim is a great blocker.</p> <p>Robin: Robin is the hardest worker we've ever had at the high school. She makes everybody better she plays with.</p> <p>Edna: Ermalinda is a girl that others want to be with because whatever event she's in, she seems to always find a way to win.</p> <p>Lori: Lori does not always get her serve over the net. But, when she does, it's a winner.</p> <p>Tina: She is one of the most intense players we have ever seen. She works hard.</p> <p>Angie: Her father coaches at a local school. So, she gets the most out of her native abilities.</p> <p>Ruth: Her skills are good. She grew up watching her sister player at the Univ. of Alabama.</p> <p>Becca: Rebecca is very coachable. She'll improve fast if she gets a chance.</p>
--	--

An Example Model-Eliciting Activity: The Volleyball Problem

The *Volleyball Problem* is a middle school version of a case study that we saw being used in Purdue's Krannert School of Management. But, it is a problem that is common in many different fields where it's often important to rank things (e.g., products, people, places, or businesses) by aggregating a variety of different types of qualitative and quantitative information about them. For example, such ranking procedures are used in consumer guidebooks that assess automobiles and other products; they are used in "places rated almanacs" that rank cities, states, or regions according to their "live-ability"; and, they are used when teachers assign grades to students in their courses by merging information about performances on tests, quizzes, projects, and other assignments. Relevant procedures may involve quantifying qualitative information; assigning weights to reflect the relative importance of different types of information, and combining these factors using some type of weighted average - or some type of iterative process that does not depend on a single formula.

The goal of the problem is to develop a procedure that the camp councilors can use to form teams that are as equivalent as possible - based on information that is gathered during try-out activities that occur during the first day of the camp. Notice that the try-outs produce several different types of qualitative and quantitative information. So, the procedures that students develop usually begin by finding some way to combine this information for the purpose of ranking campers from best to worst. Issues that arise involve not only developing ways to aggregate information within and across categories, but also developing mathematical ways to compare (i.e., order or equate): (a) scores within categories, (b) campers both within and across categories, and (c) teams. ... Solutions often range from procedures that involve implicit uses of either:

- linear combinations: $y=ax+by+cz+dw$
 - vectors: $v(a,b,c,d)=i(a)+j(b)+k(c)+l(d)$ or
 - procedures that use a series iterative processes that cannot be collapsed to a single function.
- note: Simple linear equations differ from vectors in that they involve the same kind of quantities (i.e., quantities that can be combined).

An Example "Math Rich" Newspaper Article: Volleyball Champions

Huntington, IN - For years, volleyball has been the focal point of the fall semester at several high schools. Muncie Burriss and Mishawaka High School in Indiana are perennially among the best in the nation. Their success has not come by accident. Great leadership and excellent coaching have helped to put these two schools on the map for their success. Coach Smith of Mishawaka High School attributes his team's success to their work ethic.

Each morning the athletes come in to lift weights. Once a week, athletes and coaches at each school study films to observe techniques and to watch traits of their competitors. In addition to lifting weights and watching films, the teams practice six days a week.

Not only do the athletes work hard, they also have strong attitudes about keeping alive the winning streaks. Upon being interviewed, athletes at each school point to the fact that they feel an obligation to keep the winning tradition alive. "We feel like we owe it to the girls that preceded us," states Mariana Sailors of Muncie Burriss. "They were so successful and we just don't want to disappoint them."

Another thing that athletes and coaches agree has helped each team to continue in their winning ways is a summer volleyball camp. This camp is held each summer from the second to the fourth week of June in Huntington, Indiana. Huntington College hosts the camp, and professional players are brought in from the summer circuit when time permits.

At the end of camp, a volleyball tournament is held. High school girls from across the Midwest, ages 16-18, are paired with one another for teams. The organizers of the camp are coaches from the Big Ten and the MAC (Mid-American Conference). They make an attempt to split girls from the same school so that no advantage exists for one team.

In the past few years some teams have seriously defeated other teams. Mariana Sailors recalls coming to the camp last year and losing one match 15-3, 15-2, 15-6. "It was a humbling experience," states Sailors. "I came to the camp for two reasons. First, I wanted to improve as a player. Second, I wanted to compete against other teams and individuals." With the current system in place, it is not uncommon to get destroyed by the competition.

Some have mentioned that a tryout system should be in place. If this were the case, then the coaches and organizers would have a more systematic way to formulate teams. With the current system, the coaches and organizers have no way to establish equally competitive teams. Players are always talking about what to do to change the system.

Because of the lack of competition in the tournament, interest in the camp is decreasing. The camp does offer players the chance to learn and improve their volleyball skills, but the tournament isn't as fun as it could be. Even the players that win regularly in the tournament are getting bored. They too would rather face stiff competition than win their games easily.