

Exploring the game of "julirde": A mathematical-educational game played by fulbe children in Cameroon

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Mathematics develops dynamically. Each day, thousands of mathematical problems are solved and many more new problems are invented by people all over the world, from China to Brazil, from Australia to Canada, from Finland to South Africa. Mathematical activity is both a human and a cultural activity. Mathematical ideas and methods vary from culture to culture, and our understanding of what constitutes mathematics grows as these ideas and methods enhance one another.

Today, mathematics education is meant to introduce pupils to mathematical problem solving, communication, reasoning, and connections (NCTM 2000). Teachers may look for suitable activities from diverse cultural contexts and analyze how these activities may be integrated into their teaching to create a truly stimulating and enriching environment to help all pupils fully develop their potential. Some activities will appeal more to some pupils than to others, but if the activities are effectively integrated into the curriculum, collectively they may empower all pupils, broaden their cultural and mathematical horizons, and deepen their understanding and learning.

This article presents an example of an educational mathematical activity from Africa that I have used successfully with young students. The article offers several suggestions for exploring this children's game from the central African country of Cameroon in the elementary school mathematics classroom.

A Fulbe Game

In 1936-37, the French ethnographer Lebeuf observed and described children's games among the Fulbe people of Garoua in northern Cameroon, near the border with Nigeria. One such game is the "game of the mosque," or julirde in Fulfulde, the language of the Fulbe. The cattleraising Fulbe people, who inhabit an area from Senegal to Cameroon, "have always placed great emphasis on education" (Diallo 1985, p. 38), as reflected in the following Fulbe proverb:

Janngi faamaali

Faami janngaali

Janngaali faamaali

Ko be tato wonoyota fii

Lancugol Fuuta Jaloo

The one who learnt without understanding

The one who understood without learning

The one who neither learnt nor understood,

Those are the three who will eventually

Cause the destruction of Fuuta Jaloo [Africa]. (Diallo 1985, p. 40)

The game of the mosque is usually played by several boys, although numerous other games exist that are played by both genders (see Gerdes [1999]). To play the game, the first boy marks eighty-one small holes in the sand with his middle and index fingers. Together, the holes form a square net of equidistant points (see fig. 1). The second boy must use one finger to draw line segments that link all the points, except the one in the center of the square, without retracing any segment. In doing so, he must create a symmetrical design with four free spaces that correspond to the entrances of the mosque. When drawing the line segments, the boy can proceed from any point only to a neighboring point belonging to the same row or the same column of points. Figure 2a shows a solution that corresponds to the one observed by Lebeuf (1991, p. 142). The letter E indicates the four entrances to the mosque. A similar design (see fig. 2b) has been observed on a Fulbe warrior's tunic from Senegal (Prussin 1986, p. 90). Although Lebeuf presents only one solution, we can assume that in the Fulbe informal educational context, other solutions were invented and experimentation with the dimensions of the square net took place. Let us explore this problem-solving context.

Julirde Explorations

The game of julirde is an intriguing, suitable activity for mathematical exploration, both in Cameroon and in other parts of Africa and the world. The figures may be drawn, for instance, on the floor of the classroom, on dotted paper, or on a geoboard. Both girls and boys may be challenged to find the Fulbe solution shown in figure 2a. Is the Fulbe solution the only one possible for a 9-by-9 reference frame? Teachers may wish to suggest that students start with smaller reference frames, such as a 3-by-3 or a 5-by-5 frame.

The following dialogue and illustrations describe a 5-by-5 reference frame that I explored with my eight-year-old daughter, Lesira. This dialogue serves as an example that teachers may use to encourage and extend their students' thinking.

P. G. Let us play this game. Try to draw a loop [a simple closed curve] that passes through all these points with the exception of the one in the center. You may link only neighboring points, like this:

L. G. Not like this:

P. G. That is right. Now try. [Lesira starts.]

L. G. Oh no, I cannot close the loop

P. G. Well done, you succeeded in producing a loop, but does it pass through all the points? [Lesira continues.]

L. G. Here, dad, this one.

P. G. I like it. Where did you start?

L. G. Here [pointing to the bottom center point].

P. G. Look what happened with this segment above where you started. You traced it twice in returning to the starting point. Can you draw a loop without tracing any segment twice? [Lesira makes a new drawing.]

P. G. Is it really a loop?

L. G. Oh, it did not close. [She tries again tentatively.]

L. G. No, I have to turn earlier. [Lesira finds the following solution:]

L. G. Here, papa, I did it!

P. G. Excellent. Now, look here, if two people sit on opposite sides, do they observe the same shape?

L. G. No, from the bottom, it looks like a d, and from the top, it looks like a p.

P. G. That is right. Can you imagine a letter that looks the same from opposite sides?

P. G. The letter C or B.

P. G. Are you sure? Observe well.

L. G. The letter S.

P. G. Tomorrow, you may try to make a loop that looks the same from both sides, like an S. [The game continues the next day.]

P. G. Did you succeed?

L. G. No, it did not close.

P. G. If you start like this, where should the other person see a segment?

L. G. Over there, on his left.

P. G. Now, Continue the line from both ends.

L. G. Like this?

P. G. OK. Now, be careful! How should you continue?

[Lesira advances step by step, analyzing the possibilities:]

[She ultimately advances with the following configuration:]

[She then finishes with the following diagram.]

P. G. From these two sides, what do you see?

L. G. Just the same. The four people see the same.

Figure 3 shows two of Lesira's drawings when she looked for a similar solution with a 7-by-7 reference frame. She attempted a number of different solutions unsuccessfully before she completed the final one, which has fourfold symmetry.

Extending the Exploration

The Fulbe game starts with a 9-by-9-point reference frame, or 81 points. When the square net has an odd number of points, the center point is not connected. A reference frame that has an even number of points, such as 4-by-4 frame, however, has no central point. To play the game with an even-by-even square net, the line figure should link all reference points. Figure 4 shows several solutions with different properties on frames of different sizes.

How many solutions with rotational symmetry exist for other frames, such as a 7-by-7 or an 11-by-11 reference frame? How many solutions with line symmetry can be found? Can solutions be found that have fourfold rotational symmetry, twofold rotational symmetry, or line symmetry? How many solutions

can be constructed in each example? What if the number of entrances may be freely chosen? Can the game be played with nonsquare rectangular reference frames? Can we imagine a three-dimensional version of the game (see fig. 5)? How would the rules be formulated? Mathematical and

Educational Benefits

The suggested activities develop students' problemsolving capacities. Concepts of symmetry, including line and point and twofold and fourfold symmetry, can be developed and consolidated. Numerical relationships can be explored. For instance, pupils can use geometry to discover that the square of an odd number is always 1 plus a multiple of 4; for example, $7 \times 7 = 1 + 4 \times 12$. The square of an even number is always a multiple of 4. Students can be introduced to enumeration problems when the teacher asks, "How many solutions can you find?" Students also learn to change systematically from one solution to another until all are found. Occasionally, pupils will discover that some problems do not have solutions, whereas others have multiple solutions. More advanced pupils can be introduced to the exploration of symmetries in space.

I invite you to find possibilities for further exploration of the julirde game. This exploration may stimulate you to further reflect on the educational benefits of exploring mathematical ideas that arise in various cultural contexts.

Other African Cultural Activities'

The julirde game is not the only one played in the sand by Fulbe boys. Nor is julirde the only game that uses reference systems and requires certain solutions. Figure 6 shows a solution for a puzzle that can be solved by producing a symmetrical line that joins, in one enclosure, the four outer points on the cross together with the center point. In other parts of Africa, interesting sand-drawing traditions exist in which lines also embrace the points of a reference frame. Figure 7 shows a beautiful drawing belonging to the song sand-drawing tradition, predominantly from northeastern Angola. The children's book *Drawings from Africa* (Gerdes 2000) offers suggestions for exploring the sona in an educational context.

Further Reading

Such books as the classic *Africa Counts: Number and Pattern in African Cultures* (Zaslavsky 1999); *African Fractals: Modern Computing and Indigenous Design* (Eglash 1999); *Women, Art and Geometry in Southern Africa* (Gerdes 1998); and *Geometry from Africa: Mathematical and Educational Explorations* (Gerdes 1999) present further geometrical designs and ideas developed in African cultures, which are extremely rich in their diversity. For reflections on mathematics education and culture, I also recommend *Ethnomathematics: Challenging Eurocentrism in Mathematics Education* (Powell and Frankenstein 1997).

[Reference]

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