Quest Journals
Journal of Research in Humanities and Social Science
Volume 9 ~ Issue 9 (2021)pp: 54-60
ISSN(Online):2321-9467
www.questjournals.org

Research Paper

Providing solutions on problems related to touristic beaches. Comparison ofthe mathematical explanations given by professionals and students

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ABSTRACT:*The objective of this work is to compare the solution of problems that tourism professionals use in their work, and the way that Junior High School students solve the same problems, specifically problems that have to do with the simple mathematics used to solve a real life problem related to dividing up an area like a beach in order to be exploited by beach umbrella rental providers. Specifically, these problems have to do with definitions and distribution of the coastal zone in areas of responsibility, construction of booths to protect materials, etc. The problems were given to students and also a professional who rents umbrellas on a beach. The results show that the ways used by the teenage students assigned to solve the problems are different from the methods used by a worker on the beaches.*

Received 05 September, 2021; Revised: 16 September, 2021; Accepted 18 September, 2021

I. INTRODUCTION

Much discussion surrounds the type of mathematics used by professionals and what relation these mathematics have to school mathematics. In this work we examine the mathematics used by professionals in tourism-specifically beach umbrella managers- in relation to the mathematics used by junior high school pupils to solve similar problems.

Specifically, in this work we make a comparison between the solutions to simple mathematical problems (e.g. what happens if this area is enlarged or reduced, how a protective shelter is constructed and what materials are needed) which a person renting beach umbrellas will encounter when he/she wants to divide up the area of responsibility with colleagues and the mathematical solutions given by Junior Secondary School pupils.

Considering the above, the research question of this work is if the solutions of mathematical problems in terms of touristic beaches proposed by umbrella personnel differ from those proposed by students using school mathematics. Initially we surmised that the type of mathematics used by the tourist professionals would differ from the mathematics taught in school.

THEORETICAL FRAMEWORK

Many works examine the chasm between school and everyday life [16]. There are even works which refer to the wide gap that exists between school mathematical practice and out-of-school situations. [18]. The above includes the reflections of Vroeijenstijn[23] who notes that since society demands value for money or anything else that is practical, students wish that research and education contributes to their individual development and prepares them for a position in society and employers wish education to provide students with the knowledge, skills and attitudes needed at work.

The practice of activating students' real-world knowledge is based not only on theoretical deduction, but also on empirical data. Students have been shown to demonstrate more advanced mathematical reasoning in real-world settings [4] and theyhavealso been shown to perform better in academic settings when those settings appeal to real-world knowledge [22].

One line of thought today is that if mathematics teaching is to reflect the mathematics used by professionals then there should be feedback as to what kind of mathematics should be selected to be taught in schools. This line of thinking is not new. Since 1968 Freudenthal[6] has raised the issue to an international audience of mathematics educators by expanding upon the theme 'Why we should teach Mathematics that is Useful.' This theme has continued to resonate with mathematics educators around the world. There has been great discussion in the last three decades and there have been a variety of studies of what is alternatively referred to as 'out-of-school' mathematics [18], as 'everyday' mathematics [13], [14], [15], 'ethnomathematics', 'street' mathematics [20]. Studies of street mathematics continue to be carried out (for example, [10], [8], [7] dieters and shoppers [13]. Brazilian street vendors [20], candy sellers and South African carpenters.

Thus, in the light of these findings, a dialogue has been created in which many researchers have begun to look closely at how situations can be arranged to encourage students to draw on their real-world knowledge when solving math problems in school [20].

We specifically mention one study where Lave [17] has shown how arithmetical activity in the real world does not reflect the formal procedures taught in the classroom. And there is a wide gap between this formally taught system and the strategies needed in the world outside [4],[1],[6].Lave's early study of the use of arithmetic by Liberian tailors [13],[14],[15] and [16] is in many ways a typical example of studies of arithmetic in other cultures [8].Lave's study records two things that cannot be challenged: firstly, that some arithmetical competence can be learned without schooling; secondly, that those who attend school learn some arithmetical competences that are not so easily picked up in out-of-school situations. So Lave studied 63 tailors. Through the arithmetical problems that were given them, the tailors who had received a basic education differed in their solutions only slightly from those who had received no education [13]

Empirical studies are in congruence with Freudenthal's ideas about the universal presence of commonsense mathematical knowledge as demonstrated by studies of whole number understanding and counting [11]. Likewise, as Freudenthal suggests, the content of commonsense understanding can vary depending upon both individual history and the social milieu. Researchers have tried to capture the commonsense nature of everyday mathematics with an eye towards understanding what causes variations across individuals with different experiences. Given that the practices and contexts of everyday mathematics differ substantially from the contexts of school mathematics, however, it is hardly surprising that people who are mathematically competent in everyday contexts may be unable or unwilling to do similar arithmetic in school or test contexts [1], [17]. However, there is also evidence that students do employ occasionally in the school context mathematical competencies not included in the curriculum [2]. One of the issues that this study addresses is under what circumstances might everyday mathematics be integratedin the classroom practices. Influential studies have investigated the fact that calculations in everyday situations are not undertaken for their own sake but in service of practical activities and the calculations that people encounter in many everyday situations typically involve small and 'round' numbers, the most usual arithmetic practices being addition, subtraction, and multiplication of 'simple' numbers (e.g., doubling or trebling). Where calculation is called for in everyday situations, it does not take the form of the (school-taught) pencil-and-paper application of a place-holding algorithm, but rather, most calculation involves the use of 'mental arithmetic' (which features such procedures such as memorised results, rounding up, estimating, or approximating). When we compare schooled and unschooled children, we find that they perform equally on the simple problems that they encounter as part of their everyday lives – but that schooled children perform better at complicated problems ('school-problems') [9]. This research project maintains that everyday mathematics is best studied as a process that takes place in the context of specific practices.

It extends this idea to examining school mathematics as well. Thus,extensive observations were made in both stores and classrooms as children carried out activities with money given that individuals' goals are conceptualized as a critical element in everyday mathematical practice [19],[6]. The importance of common sense is stressed as the root of early mathematical development. 'In the course of life, common sense generates common habits, in particular where arithmetic is concerned, algorithms and patterns of actions and thoughts, initially supported by paradigms, which in the long run are superseded by abstractions. According to Freudenthal, children's common sense of mathematics is acquired 'in the stream of their physical and mental activities' and 'may depend on the community that shares it'. He notes that mathematical development is impeded when students fail to connect their algorithmic learning in school to their commonsense understanding from outside of school. Weber and Alcock [24] describe two paths someone can take that result in a correct formal mathematical proof. The first path is "syntactic proof production" which refers to a proof written through manipulation of definitions and theorems that does not utilize non-formal representations. The second path is "semantic proof production" which refers to constructing a proof by using ". . . instantiations of the mathematical objects . . ." relevant to the statement being proved (Weber &Alcock, 2004). It could be argued that Congruent Corresponding Parts proofs in Euclidean geometry are more likely constructed using syntactic proof production while transformational proofs are likely to be constructed using semantic proof production. Weber and Alcock[25]) also suggest that in order to construct a semantic proof one must be able to connect the instantiation of an object, which one reasons with, to the formal definition. Data suggests that participants in the "Connections" study were not able to make this connection with transformations.

PARTICIPANTS.

There were four individuals participating in this research, all residents of a large island. Three were students in the 3rd Year of Junior High School who were selected by their class teacher as good students. The fourth participant was a beach umbrella manager, who had himself completed Junior High School. The business was his own (he was not an employee). He rented from the Municipality his concession to work the beach with another 10 colleagues. Each one had a section of the beach to work on. Further, these particular professionals often fixed upon the beach rough and ready structures to protect themselves from the sun and also to protect their equipment (umbrellas, beach beds etc) from theft during the night hours.

The beach umbrella manager had great experience in dividing his area of responsibility so that he could set up his umbrellas but also in case he was given a different area. Similar problems were in turn given to the students, finding themselves on the same beach having to spread out the umbrellas evenly, change their area of responsibility, and then describe on paper how they might create a booth.

DATA-COLLECTION TECHNIQUES

Interviews were held with both students and professionals.
In brief:
-The interview was approximately 30 minutes. The same amount of time was given to the students.
-Collection of Information: We collected the observations data during each of the umbrella manager's actions.
-They provided contextual information on the umbrella manager, which could be matched against the video recordings.
-We used a narrative system for obtaining these data [5].
-We tried to collect the information on these individuals and at the same time we tried to record personal reflections (feelings, doubts, ideas, etc.).
-We used Video – DVD. Specifically, the camera followed the beach umbrella manager on the beach. The elements selected were recorded in order to make their processing easier. The students were similarly recorded while giving their own explanations, and at the same time the worksheets that had been given to the students were used.

1st Part of the Activities.

We had a report from the professional as to how he divides the whole beach into the areas of responsibility of the rest of his colleagues at the beginning of the season. It is clarified that in the years 2017-2018for two consecutive years, while being the research carried out, the entire beach of 2,500 metres had been divided among 10 professionals.

The beach umbrella managers each have their areas of responsibility which were on the 2.500 meters of beach, an area which would be increased if a further hotel unit was given 150 meters more of the land towards the sea for public exploitation, i.e. 2.500 meters of beach is now increased by 150 meters becoming 2650 metres.The number of beach umbrella managers however remains the same-10 individuals. They were asked how the space can be divided from the start among the 10 umbrella managers to present the way of measuring the surface area of the beach. They were also asked to present how it is possible to change the areas of responsibility following the need to cover the additional 150 meters of the beach with umbrellas.

Finally, they were also asked if it would be good to reduce the density of the umbrellas which they placed along the entire surface of the beach. Below, in the 1st part, we present part of the dialogue between the Researcher and the Umbrella Manager, while immediately after we present the dialogue between the Researcher and the Student.

Part 1 :Dialogue between the Researcher and the Umbrella Manager

The researcher asked the professional the way in which he divided the beach into areas of responsibility.
Professional: At the moment our areas of responsibility are about 250 meters since the beach is about the same width for its whole length we can divide it into slices perpendicular to the shore so that all the umbrella managers can have the same size area of responsibility.
Researcher: How is each person's area of responsibility divided amongst you?
Note: It is explained to us that the boundaries of each patch are measured at the beginning of the season.
Professional: That is to say, we umbrella personnel know that section A which is on the beach as far as Section X is the area of responsibility that the Municipality has granted us. We 10 must measure the area granted us by the Municipality at the beginning of the summer. Then we divide the area into ten sections. If we find, for example, that the whole area is 2,000 paces we must then divide that into 10 parts.
We begin by pacing off and measuring the first individual 200 paces. Where that patch ends, the next person's portion is measured off and so on. Only one person paces out the divisions to ensure that the paces are of the same length. For example I, who am 1.78m tall, have a different length of stride from someone who is 1.90 tall. In order not to get confused and to avoid having to start measuring again from the beginning, as each patch is

finished we place a marker in each measured section. If the beach is measured again by someone shorter than I am certainly he/she will have a shorter stride, and will have to take more steps, but again those steps will have to be divided by 10. It's the same thing.
Researcher: What will happen if the distance increases by 250 meters?
Professional: The number of paces will increase as well. Since there are ten of us we will each get another 25 paces. So we would have to start measuring from the beginning of the beach with 275 paces. We would be sure then to have covered the whole beach taking in the area of the new hotel.
Researcher: If the Umbrella managers don't want to add more umbrellas to the beach what must they do? Might it be good if he told us the number of umbrellas being used now?
Note the professional stopped, though for a minute and said that it wouldn't be necessary. He pointed out that at that moment he left 10 paces up and down and ten paces left to right. If the length of the beach was now increased by 250 meters (i.e. 100 paces) and the number of umbrellas remained the same it would leave 1 more step between them.
Researcher: How did you work that out?
Professional: The 100 paces are divided into 10 portions, so each patch will get 10 paces more.
Note: Next we investigated the way in which the professional went about creating a booth in which to place articles such as boards, umbrellas, deck-chairs, beach-beds etc.
Umbrella Manager: I determine by eye the total space I need to set up the booth, then I measure it by pacing out the area I need to store the umbrellas, so that I can go to a shop that sells galvanized tubing.
Researcher: And what type of tubing will you buy for this case?
Umbrella Manager: Looking at the area you are pointing out to me, I will buy two pieces of tubing for each corner and 2 for each side – so a total of 12 (4+4=8). The distance between pieces of tubing is 2 paces and it will be 2inch tubing. In the emporium you can also find 3m long tubing. I will make holes in the tubing then I will install them about 10 palm-widths deep in the ground. Into these holes I will place the wood in order to construct the booth. Of course there are places where the wind blows very strongly and the sand is less dense. In that case the tubing must go deeper or be set in a concrete base. That's not difficult. You can get big 20 kilo boxes and place the bars inside them. If you do that the depth to which the tubing may be sunk in the sand is 3 palm widths.
Researcher: Howwillyou construct each side of the booth?
Umbrella Manager: I'll buy planks 2m x 15cm width. So we can think of one plank as having a surface area of (2x15)x100= 3000 squarecentimetres – so 3 square meters.
Each side is about 3 paces, that's to say about 4 meters. I have already placed the tubing 10 palm-widths deep in the ground, say about 60cm, and I've got 2. 40m left over. Because each side of the booth is the same I multiply 2.40 by the 4m and the width is 3 metres, I will multiply the surface area by the height and that by 2. At the same time it must be borne in mind that a 2.10m x 0.90m frame must be set for the door to be installed.

Part 2 Dialogue between Researcher & Student
Similar questions were put to the student. The researcher went with the student to the beach. The researcher asked the student to set up umbrellas all over the length of the beach.
The students carried out the following line of thought
Student: We should measure the whole distance where the umbrellas will be placed. It would be good if the beach was the same width for all its length.
Researcher: How will you do it?
Student: I'll go to the end and I'll measure the two right angled lines. The one would reach the shore and the other would stretch to the end of the area of responsibility that the umbrellas need to be set up in.
Researcher: In your notebook can you describe for me the way in which the beach will be divided up?
Note: The first student attempts (even though he has not yet taken any measurements) to share out the beach area using division.
The second student gives an answer based on the number of individuals in the group who would have a share. Specifically he said that for a fair distribution of the umbrellas the number of people in the croup or family should be considered so as to place the umbrellas with a logical and correct distance between them.

Researcher: The distance is very large. The measuring tape you have,will not be long enough.
Student: I'll use the tape starting where the beach begins and I'll measure off the first 50 meters, since it's a 50 meter tape, and there I'll place a marker. Then I'll measure the next 50 meters and place another marker. Placing the tape at the marker each time I can measure as many times as needed. For the width of the beach this 50 meter tape is long enough.
Researcher: Let's begin.

Note: The student began to measure the beach. Sometimes he repeated the measurements since he thought that he had not measured correctly. Sometimes he got mixed up or even forgot how many times he had unfolded the tape. Writing the measurements down in his exercise book helped considerably in keeping him unconfused.
Researcher: How big is the beach?
Student: Without the new hotel it's 2500 meters. With the new hotel it's 2650
Researcher: Is the placement of the umbrellas correct at this moment?
Student : Yes. Each umbrella is evenly spaced from two other umbrellas in each direction. I will divide the 500 metres among the 10 professionals. That's to say, where the position of eachone ends I'll transfer by 50 metres.
Researcher: Since you say that the distance with the new hotel is 2500 meters, how can you divide the new distance and keep the same number of umbrellas?
Student: I'll divide the new size of the beach by the existing number of umbrellas to find out how much more space each umbrella will have.
Researcher: I think that the width of the beach is the same for the entire length.
Student: You're mistaken. Here you see that the sea cuts into the land with the result that the width of the beach decreases while a few meters further along it's wider.
Researcher: What happens further down?
Student: Exactly the same. See here, further down the same thing happens. It's the same all along the beach.
Researcher: Shall we measure the width?
Student: It's not be necessary. It's the same.
Researcher: Now, how would you create a booth?
Student: I'll divide each side if the space that the booth will occupy at the points where I will put the support stakes. So, since the total length is 8 meters, and I will place 4 supports at intervals.
Researcher: Will you think again about that 4 .
Student: At 5 intervals.
Researcher: Correct. How will you prepare the booth?
Student: I know the standardised dimensions of the timber that is sold in the emporium. Then I will hammer a stake about 0.5m into the sand then from that stake I will divide as long as the width of the timber. I will measure the length then I will divide this length by the width of each piece of wood like the ones they have in the emporium. That way I'll be able to order the wood I need. As far as the roof is concerned I'll follow a similar process and multiply the length by the width and so buy the wood that is needed.

COMPARISON OF THE EXPLANATIONS OF THE STUDENTS AND THE UMBRELLA MANAGERS.

From the above section of the dialogues between the researcher and the umbrella managers and the students it can be seen that the students choose different ways of mathematically solving the problems met by someone who is running a business on the beach.
These differences have to so with :
1. Methods of measurement: the use of paces by the professionals as a unit of measurement compared to the use of a tape measure by the students.
In order to ensure the stability of the measurements the professionals use the paces of one person so that the stride will be constant, while thestudents use a 50m cord which they stretch out repeatedly until they have covered the whole length they are so measure.
2. Limits of the area of responsibility (beginning and end of the areas of responsibility of other professionals). The areas of responsibility are appointed by placing markers at the top of the beach, whereas the students placed markers in the sand.
3. Determination of the new points of measurement.
When they were asked to make an extension (enlargement of the areas of responsibility of each post) the professionals measured the area again from the beginning. Then they shared out the whole distance (along with the new stretch) among the relevant number of professionals.
The students divided up the length of the extent of the existing positions. Thus the 500m extension of the beach was divided into 10 sections, i.e. each section would be enlarged by further 50m.
A significant error can be seen from this way of doing things since beginning from the first section there follows the addition of 50m per old section of responsibility.
4. Calculation of the area covered by the wood of a booth.
Here too a completely different approach is seen between the professional and the student. The professionals take the surface area upon which the booth will stand as a base for their calculations of the materials that will be needed to build it. They multiply the area by the height of the booth (from ground level) in order to cover the total surface in wood, allowing for loss (cutting etc)

Note: If, for example, the area to be covered with wood is 30m the professional multiplies this by the height e.g. 2m. thus the total surface to be covered will be ground area x height from ground level (30sq.m.) instead of the (10·2)+(10·2)+ (3·2)+(3·2)=20+20+6+6=40+12=52sq.m. that the students uses.

EPILOGUE

Social interaction and the discussion of mathematic interpretations and solutions are essential for learning. The students learn that mathematics is related with activities they meet in their work and in their social environment. The students' daily experiences connected with mathematics outside the classroom, offer an environment in which informal mathematical knowledge is shaped, the kind of knowledge that is a product of the effort by the individual to deal with real situations and can be characterized as applied mathematics, depending on the circumstances within which it arises and is rich in mathematical relationships (correct or wrong). According to the relevant research, this informal knowledge constitutes a precious frame of reference at least for the students' initial attribution of meaning to mathematical concepts, representations and processes by the students, particularly when they are required to be involved in activities related to real situations, in which the use of particular knowledge is required. The encouragement of this practice contributes to the continuous exploitation of informal knowledge for the deeper comprehension of mathematical ideas, as it activates the processes of reflection that condition mathematical thought [3]. This is because they have discovered repetition as a strategy for improving their memory although no one taught them. Nektarios K did precisely the same thing, when measuring the distances to place the umbrellas, by using repetition of the distance he estimated visually.

Important benefits derive in teaching from the utilization of strategies and methods that the students use in their daily mathematical needs but also from seeing how these strategies can be extended to other types of problems in mathematics, such as those that are taught at school. This will happen only if the teachers make systematic efforts to teach learning strategies to the children. These strategies help learning and make it more rapid.

The students should be encouraged to connect school mathematics with their own experiences. Only then can they overcome the difficulties and conceive the formal mathematic proposals as representations

II. DISCUSSION:

It is a fact that each of the participants in the above research activated a different one of the three types of actions in mental activities that were identified: perceptual, mnemonic, and cognitive [26]. Perceptual actions are those by which the human being maintains contact with the environment.

They are initiated by stimuli from the environment and enriched on the basis of prior experience. Mnemonic actions refer to actions, which involve recognition, reconstruction, or recall.Cognitive actions involve thinking in terms of images of real objective processes [26].

Mathematics has developed through our human need to deal effectively with daily situations or to explain particular phenomena. However, mathematics teaching in schools, by aiming mainly at the formation of more generalized knowledge and by focusing more on the final outcome and less on the process of mathematical creation, tends to present mathematical knowledge outside the context from which it emerged, or included in situations that are connected only very loosely with the personal experiences of the students. On the one hand, such a teaching practice overlooks the socio-cultural character of the process of the construction of mathematical knowledge . On the other hand, it downgrades the importance of the various mathematical experiences that students have outside the classroom that are connected with a particular process [3].

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