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THE USE OF GEOGEBRA IN THE CONSTRUCTION OF A STUDY MANUAL ON MATAPI IN THE TRAINING OF TEACHERS FOR THE COUNTRYSIDE

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Abstract: This article aims to show how the geogebra program contributed to the construction of a study manual for making matapi (a tool used in shrimp fishing), preserving the materials used by the rural community. This study took place during a continuing education course for teachers who teach in rural education in the municipality of Cametá in Pará, and included the participation of the community that produces and uses the matapi in their work practices. The research methodology is therefore qualitative, as there were reflections on the participants' speeches during the training meetings, which were fundamental to understanding the construction and use of matapis. The results showed that the matapis made using geogebra were efficient for catching shrimp, which led to the construction of a manual on how to make a Matapi using geogebra.
Keywords: geogebra, rural teacher training, matapi.

INTRODUCTION

Teacher training for the field, whether initial or continued, does not yet include integrated work between Community Time and School Time, as shown by Molina and Rocha (2014). For the authors, it is necessary to create conditions for teachers so that they can work in school and non-school contexts. In agreement with Silva (2015), we understand countryside as rural spaces with different cultural, economic and political manifestations and which are made up of forest, agriculture, riverside populations, quilombos and indigenous people, for example. For Molina and Rocha (2014), degree courses in rural education, for example, the demands of the internship and educational practice that are mandatory end up directing a set of activities that focus on the school and not the community, highlighting, thus, the dichotomy between theory and practice, with School Time and Community Time distanced. This is one of the causes that generate fragility in teacher training for the field (MOLINA; ROCHA, 2014).

Still regarding this problem, Carmo (2011) reports an experience of organizing teaching for the countryside, through the alternation method at Casa Família Rural (CRF), in the municipality of Cametá/PA, where students studied for two weeks with theoretical classes and two others "exercised" the practical activity that, in theory, must apply such knowledge in practice, thus demonstrating a direct application of the school's knowledge in the community, as if there was a superiority of the school's knowledge in relation to the of the countryside (SILVA, 2019). Carmo (2011) also carried out some interviews with parents and students who benefited from the CRF educational project and seems to have concluded that there is a weakness in such teaching, as many of the students who had studied at the CRF stopped practicing the techniques learned in their due to the change in education systems: "at the end of the training process, CF is becoming like a formal school, by promoting schooling for young people. From now on, everyone seeks their own path" (CARMO, 2011, p. 42).

Based on this problem, we set up a continuing training course for teachers who teach in schools located in the countryside and proposed, in line with the community's wishes, the theme for study: "Construction and use of the matapi, dialogues between school and time community time." Then, the teachers made the matapis with the help of the community master who taught them the practice. It was modified based on models built in the geogebra program, but preserved the community's desire to make matapis using jupati splint, as it is economically more sustainable, as shown by Araújo, et al. (2014). In these terms, the objective of this article is to show how the geogebra program contributed to the construction of a study manual for making matapi, preserving the materials used by the community.

REVERSE DIDACTIC ENGINEERING

Reverse Didactic Engineering (hereinafter EDR), understood as a Study and Research Path for training rural teachers (hereinafter, PEPS-FP), inherits the genetic characteristics of 2nd generation didactic engineering, which is a research methodology, with in it, PEPS-FP is seen as a teaching and research methodology. This way, 2nd generation EDR generates processes of didactic transpositions, which is one of the main functions to identify epistemological (origin of knowledge) and ecological restrictions (the ways in which knowledge acts in different institutions, considering the habitat and niche). As presented by Barqueiro, Bosch and Florença (2022): "This step to the second generation requires important transpositive work that identifies the epistemological and ecological restoration of the new institution" (BARQUEIRO, BOSCH, FLORENCE, p. 89, 2022). In this sense, as EDR is seen as a PEPS-FP specific to the field, it leads to an external didactic transposition, when it establishes a didactic system for teaching in the field. However, before that, EDR first defines the subjects and classes that will take part in the study of traditional practice. EDR also generates an internal didactic transposition, as it moves internal processes of deconstructions and reconstructions of knowledge, causing subjects to reconstruct their ways of thinking and acting in the face of a human or teaching practice, aiming for their improvement. Silva and Guerra (2022, p. 336-337) show 6 phases that make up EDR:

(1) Definition by the class [F, P], with the help of the school-community, of a traditional practice Ω carried out by the community;

(2) Appointment of an agent from field A, with the help of the school-community, a specialist in traditional gaming practice;

(3) Deconstruction of the traditional practice by class [A, F, P], with the direction of agent A to reveal the elements that constitute this practice. Here the didactic system is established [S (P, F, A, Ω)] ➡ $M_{\Omega =}$ {traditional knowledge} ➡ Rm= Practice construction manual: Ω;

(4) Construction of the transposed practice: Ω' by the class [F, A, P], under the direction of F, considering school knowledge not defined from what comes before. Here the didactic system is established [S (P, A, F, Rm)] ➡ $M_{Rm =}$ {traditional knowledge} U { school knowledge } ➡ Ω' = Study manual for the construction of practices of this type: Ω;

(5) Validation of Ω' by class [A, F, P], considering the practice: Ω' compared to traditional practice: Ω. Failure to validate implies a return to phase 4;

(6) Construction of school knowledge teaching sequences based on transposed traditional practice Ω'.

Thus, of the 6 phases of EDR, we will show here only the 4 phases, used to study the matapi of the community of Pacuí de Cima, in the municipality of Cametá-PA, while we first consulted the masters of that locality if they were in favor of working with such an instrument and they told us that it was feasible for the school to teach students how to do it. However, they made it clear that it must be the traditional one, that is, made with Jupati splints as a way of preserving local culture and the environment, as it pollutes less than the one made with PET bottles. This way of thinking of the producers of this practice is in line with the thinking of Araújo, et al. (2014) in which they defend the use of traditional products, because they have lower environmental impacts than pets. In this context, the next topic shows how the construction stages of the matapi were developed through the 4 phases of EDR.

METHODOLOGY

The present work is also a qualitative research, with reflective analysis of the interviews that were carried out with the master matapi producers in the community of ``Pacuí de Cima``, located in the municipality of Cametá, state of Pará. This development was also carried out, together with the teachers who participated in the continuing training, which covered the theme: "construction and use of the matapi, dialogues between school time and community time". The course was offered as an extension activity by the Faculty of Mathematics - Campus Universitário do Tocantins Cametá/UFPA.

To this end, based on a reflective analysis, we sought to try to answer the question: how did the geogebra program contribute to the construction of a study manual for making matapi, preserving the materials used by the rural community? To try to answer the question, 14 combined training meetings were held between the ``Pacuí de Cima`` community and the UFPA\Cametá Campus. Therefore, the research location took place in the aforementioned community and at the university. Participating in the training were: the master matapi producers from the community of ``Pacuí de Cima``, which we call José[1] and Zeca[2] and acted as directors of the internal study, proposed by phases 01 and 02 of the EDR and mentioned above. They conducted the construction stages of the matapi for a group of 10 teachers who teach in the initial and elementary years II, namely: 4 pedagogues (one of them also has a degree in History); 5 mathematics teachers, one of whom has a degree in Physics; 1 Portuguese language teacher.

Thus, to study the questions raised and the discussions surrounding the construction and use of matapi, the following research instruments were used: semi-structured interviews with audio recordings, in addition to video recordings, which show the teachers' training process from collecting the material in the forest, extending the discussions at the university.

We present, below, a summary of the 14 meetings held on the construction of the matapi as a practice transposed into a manual, studied through the 4 phases of EDR.

SUMMARY OF TRAINING MEETINGS IN THE CONSTRUCTION OF MATAPI

In the 1st, 2nd, 3rd meeting, José taught the teachers how to build matapis, showing them the steps and materials for this construction, such as: dried jupati splints [3]; 3 mm nylon thread, for weaving the pari-carpet; ``cipó de cebola braba``[4] and ``agra chama`` [5], to make the internal wheels of the matapi; pitch milk [6], to give greater resistance to the nylon thread

1. Fictitious name and corresponds to gender

2. Fictitious name and corresponds to gender

3. **The splints of Jupati seca:** occur through exposure to the sun of living splints, removed from the branch of Jupatizeiro- (*Raphia taedigera*) (MORAES, 2005, p.66)

4. **``Cebola braba``:** vine whose scientific name is *Clusia grandifloro Split.* Family: *Clusiaceae* - (Botanical Identification Report, Embrapa/Belém, typed on 02/14/2020).

5. **``Agra chama``:** vine whose scientific name is *Clytostoma bina tum* (Thunb). Sandwhite-Family: Bignoniáceo - (Botanical Identification Report, Embrapa/Belém, typed on 02/14/2020).

6. **Pitch milk:** extracted from the fruit of the Anani tree, known as: *Symphonia globulífera*, commonly called oanani, guanandi, olandi, anani and ananim, is a tree native to Latin America and tropical Africa. (WIKIPÉDIA, 2020, section: *Symphonia*

in terms of tongue weaving [7]; white nylon, to make the "enchuliamento", which is used to sew the wheels and tongues to the body of the matapi after its insertion [8] with the help of the reed needle; nylon number: 36, used for weaving the smaller circular edge of the tongue.

Other materials used were: double-layer nylon, used for weaving the central part of the tongue, as it provides greater resistance to the tongue tie; the knife, for cleaning the splints, cutting the materials; pliers, to make cuts on the smaller circular edge of the tongue, adjusting the tips of the splints; clapboard,[9] as a standard measurement for constructing the length and height of the matapi; lighter, to burn the end of the nylon thread so as not to tear the tongue, in contact with water; and brush, to mark the division from one braid to another of the pari. The use of these materials reflects José's personal knowledge.

The aforementioned materials were read by us as an oral manual – organized by José – on how to make a matapi, as it was not textualized, but endowed with a technical rationality, which explains its use in the construction of the matapi. In this sense, it is pre-construction knowledge.

After construction, we deconstructed this practice, raising some questions that led to 7 key questions:) Q_1, Q_1 Length and height of the matapi? Q_2, Q_2) Largest tongue diameter? Q_3, Q_3) *Smallest tongue diameter?* Q_4, Q_4) Distance between splints? Q_5, Q_5) Distance between languages?Q_6, Q_6) *How can they relate the construction and use of the matapi with school knowledge??* Q_7, Q_7) how to prepare a Matapi construction manual?

In this context, questions arose as we problematized the matapis through the process of internal didactic transposition, lasting in the: 4°, 5°, 6°, 7°, 8°, 9°, 10°, 11°, 12°, 13º, training meetings.

At the 10th meeting we raised the question which included the teachers' answers regarding the questions: (e)Q_1, Q_2, Q_3, Q_4, Q_5, $Q_6 Q_1$, Q_2, Q_3, Q_4, Q_5, Q_6, which refer to the matapis produced in the first meetings, shown in Figure 02 below:

Figure 1 – Matapis models made by teachers prior to geogebra.

Source: Survey data (2019).

Therefore, as the question: Q_6, Q_6 emerged in the community of ``Pacuí de Cima`` and in the 6th and 7th meetings, teachers read the practice of construction and use through school knowledge based on geogebra,

The elements of responses to the: Q_1, Q_1, Q_2, Q_2, Q_3, Q_3, Q_4, Q_4, e Q_5, Q_5, they were sent by the teachers based on a virtual matapi model made by one of the teachers with the help of José, using the geogebra program: the notion of a circle, distances, diameter, height, length, as shown in table 01 below:

In table 02 (below), the matapis called 11, 12 and 13 were generated from the virtual projection of the geogebra program, but it was observed that the number 12 captured small

globulífera.)

7**. Language:** term used by the community of Pacuí de Cima`` in the Figurative sense, which refers to the entrances through which the shrimp enters the matapi, that is, it has the function of "swallowing" the shrimp into the instrument, hence called "tongue.". It looks like a frustum geometric figure.

8**. ``Enchuliamento``:** term used by the community of ``Pacuí de Cima``, in which white nylon thread is used with the aid of a needle made of PVC to weave the wheels of the matapi, as well as to insert the tongues.

9**. ``Clapboard``:** Piece of wood, with the function of measuring the length and height of the matapi.

and large shrimps, similar to what happened with the matapis 01 to 10 made Before the use of Geogebra, only 11 and 13 captured large shrimp. The hypothesis – whether it is due to the type of nylon, where 12 used 3mm nylon for manufacturing and generated a distance between the splints of 4mm, therefore 11 used 4mm nylon, and obtained 5mm distances, and finally, the 13 used 5mm nylon and generated distances of 6mm. This hypothesis is confirmed in table 03, below:

In table 03, matapis 11 and 12 have the same characteristics in terms of height and length, but the type of nylon thread ended up defining the distance between the splints, which meant that 12 captured the large and small ones. Due to this, the most economically sustainable, in this case the matapi number 11 and 13, as it captures only large animals, therefore, follow the study manual for making the matapi 11 and 1.3.

RESULTS

The 4 phases of EDR, developed over the 14 training meetings, led to the creation of two models of study manuals for making the matapi with the help of geogebra. These models were called the matapi 11 manual and the matapi 13 manual. Figure 4, below, shows the models built from geogebra:

Figure 2 – Matapis models made with the help of geogebra.

Source: Silva, 2019.

MATAPI 11 MANUAL TEMPLATE

We present, in Figures 5 and 6 below, the first Matapi model built using Geogebra. These manuals preserved the materials used by the rural community, such as Jupati splints, wild onion vines or agra chama and pitch milk. There was only a replacement from 3mm nylon thread to 4mm and 5mm, as they captured larger shrimp, as shown in table 2 above.

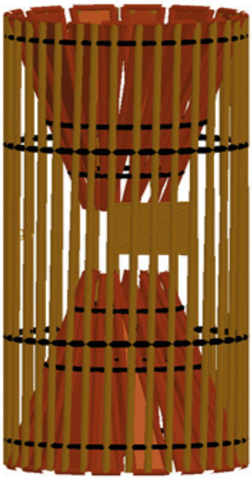

Figure 3 – Matapi 11- geogebra model

Source: Silva, 2019.

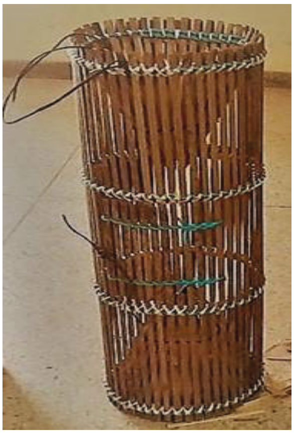

Figure 4– Matapi 11 materialized in concrete

Source: Silva, 2019.

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MATAPI	Carpet structure [1] of matapi				Matapi language			
	Length x (CM)	Height (CM)	Number of splints	Distance between splints (CM)	Number of splints	Largest diameter (CM)	Smallest diameter (CM)	Distance between the two languages (CM)
01	64	56	47	3 a 4	24	20	3, 0	12
02	64	56	43	3 a 4	23	20	3,0	12
03	65	56	44	3 a 4	23	21	2,5	13
04	65	56	43	3 a 4	23	20	3,0	12
05	63	56	43	3 a 4	22	20	3,0	13
06	69	56	45	1,5 a 2	22	20	3, 5	14
07	66	56	47	3	22	21	2,5	11
08	65	56	44	4	23	20	3,0	12
09	60	56	47	4	22	20	3,0	13
10	60	56	47	4	23	20	3,0	13

Table 1 - Answers to questions: *Q1, Q 2, Q3, Q4, Q 5*

Source: Silva, 2019.

MATAPIS	DATE/TIME 14/05/19 AS 17:30h as06: 30		TOTAL
	BIG	**SMALL**	
01	10	06	16
02	07	03	10
03	10	04	14
04	09	03	12
05	12	03	15
06	30	32	62
07	05	02	07
08	18	19	37
09	12	14	26
10	20	20	40
NEW MATERIALS MADE WITH THE AID OF GEOGEBRA			
11	10	-	10
12	41	11	52
13	10	-	10

Table 2 – Number of shrimp caught

Source: Silva, 2019

MATAPIS	Carpet construction			Matapi language				
	Length x Height (CM)	Number of splints	Distance between splints (CM)	Splint length (CM)	Number of splints	Largest diameter (CM)	Smallest diameter (CM)	Distance between the two languages (CM)
Matapi 11	74 X 70	50	5	25	26	22	3	25
Matapi 12	74 X 70	53	4	25	25	22	3	23
Matapi 13	51 X 94	58	6	51	27	22	3	10

Table 3 – Matapis measurements with the help of geogebra

Source: Silva, 2019

1**. Carpet:** term used by the community of ``Pacuí de Cima`` to refer to the initial construction of the matapi, which defines its height and length. It looks like a rectangle geometric figure, once closed it takes on the appearance of a cylinder

MATERIALS TO BE USED IN CONSTRUCTION

- Dry Jupati splints;
- NYLON No. 4 mm and 5 mm are the most suitable for capturing large and medium-sized shrimp, and copper or aluminum wire No. 18 can be used to construct the tongue, only when using 3 mm nylon, if the nylon thread is 4 mm, 5 mm, not necessary, as the thickness allows for good tying of the tongue splints;
- 3mm or 2mm nylon to reinforce the fabric of the tongue closure;
- Nylon No. 36 and 42 to close the edge, which forms the smaller circle of the tongue, it also serves to divide the tongue into two equal parts, tying the smaller part to the larger part. It is the process of not tearing the tongue apart so as not to loosen the fabric, because when it comes into contact with water, it removes the rosin;
- Measure tape (tape measure) or a piece of wood, used as a standard measurement or else scratch on the floor. This measurement determines the size of the matapi, for example, if you want to build a matapi measuring 60 cm;
- Pitch milk to give firmness to the three-layer nylon. To use it, wrap the thread around one of your toes and then take the rosin and pass it on;
- Wild onion vine or agra flame for the construction of the wheels;
- Knife, cutting pliers, to cut the circle and to cut the wire, lighter that burns the end of the nylon, needle, pick, made of plastic such as PVC, 5 cm long.

MANUAL INTRODUCTION

- Go to the forest to collect the splint and wild onion vine or agra chama. After extracting the splints, leave them for a week to dry in the sun, then cut them to the size you want to make the matapi;
- Clean the jupati splints, cut the length you want to build the size of the matapi, the same process applies to the vine;
- Organize all material for use;
- Sit on the floor or floor of the house and, with the support of your knee and foot, begin the task;
- Cut the 4 mm and 5 mm nylon thread, depending on the width of the matapi, 2.20 cm in size suggested, divide this thread into two equal parts without cutting;

Now, let's look at the steps involved in building the pari-mat and the tongue.

Note: Sit on the floor, hold the nylon with the ends facing forward and start weaving the splints.

CARPET CONSTRUCTION

- 50 70cm long splints, cut two in one;
- 4mm distance between the splints of the matapi carpet;
- 4mm or 5mm nylon thread;
- Divide the rug into four equal parts, with a distance from one braid to the other of 21 cm. In each division, use 2.20cm long nylon;
- Length x height: 74cm by 70cm.

LANGUAGE CONSTRUCTION

- 24 tongue splints;
- Diameter of the largest edge 22cm;
- Therefore, based on the first manual, a second one was created, which includes

the construction of another matapi using geogebra. Below we present the steps that make up the manual.

CONSTRUCTION OF MATAPI IN GEOGEBRA - MODEL 13

The Matapi model 13, which we call "drum", has the mat and tongue of different sizes than the 11, hence the need to textualize this new constructed practice, in addition to presenting a better visualization of the steps taken in the Geogebra program, and in concrete, as we have shown in other research already published by us (SILVA, SILVA E RIBEIRO (2020) and SILVA and GUERRA (2021). Figure 7 and 8 represent this construction in geogebra, while Figure 9 is the construction in concrete.

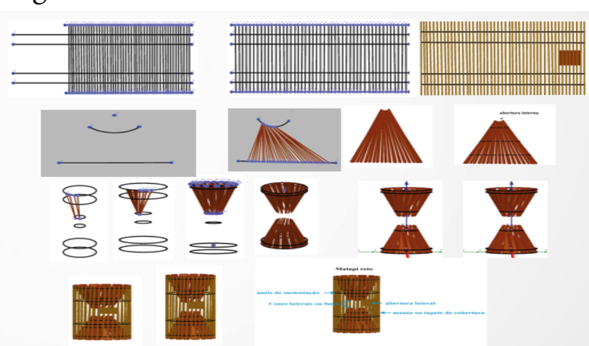

Figure 5 – Construction of matapi in geogebra

Source: Silva; Silva; Ribeiro, 2020.

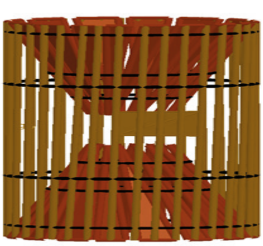

Figure 6 – Matapi 13 - geogebra.

Source: 2019.

Figure 7– Matapi 13 - geogebra materialized in concrete

Source: Survey data,2019.

RUG CONSTRUCTION (MEASUREMENTS)

- Length x height of the rug: 51 cm by 94 cm;
- 58 splints measuring 51 cm in length, which is equivalent to approximately 20 inches (50.8 cm);
- 6 (mm) distance between the splints of the matapi carpet;
- Use nylon thread from 4 mm or 5 mm onwards;
- Divide the rug into four equal parts, with a distance of 6 cm from one braid to the other. In each division, use 2.20 cm long nylon.

Once this first stage of building the pari-mat is complete, pick it up and check if everything is correct. Now, close the mat, thus forming the body of the matapi, which reminds us of the shape of a cylinder. With this, take the nylon scraps from the four ties made on the carpet, one at a time, introduce them in the same initial direction and tie them, thus closing the carpet,

Now insert the wheels to be made from wild onion vine or agra chama, in each of the four divisions of the carpet, tying them with white string measuring 2 m for each wheel. This thread is placed between the distances of each splint, and must overlap the nylon.

WHEEL LASHING

Use the string on the reed needle to reinforce the lashing of each of the wheels that make up the internal part of the matapi, total 4 wheels,

- Use this same process to sew the tongue to the matapi's body.

STAGE: LANGUAGE CONSTRUCTION

1st step: cut the splints in a two-in-one format.

2nd step: you don't need to use the wire on the tongue with nylon from 4 mm onwards, braid the splints in the same way you did on the carpet, start braiding at the end of the tongue, as shown in the image.

3rd step: apply the rosin milk to the nylon thread with 3 or 2 layers, then just braid this thread with the splint. This braid will remind us of a fan.

4th step: With the leftover nylon, braid the other end, to close the tongue, which resembles a cone trunk, then, with the same thread, divide the tongue into two equal parts and make tying the smaller braid to the larger one, as shown in the image.

5th step: press the tongue on the matapi's body, take the reed needle already threaded into the string and sew them together, tightening the string tightly around the entire circumference of the body, thus creating the final braid.

MATERIALS

- Use 27 splints to construct the tongue, cut two in one;
- Diameter of the largest edge 9 inches (ca. 23 cm), equivalent to 23 cm;
- Diameter of smaller circular edge 2.5 inches (6.35 centimeters), approximately 6cm;
- Tongue splint length 24cm;
- The distance between the two tongues is 10cm, which is equivalent to approximately 4 inches (10.16 cm);
- To braid the circular part of the smaller edge, tipiti nylon with three layers is used and for closure, nylon no. 36 is used.

Now, attach another tongue in the same way you sewed the first one, finishing successfully.

WINDOW CONSTRUCTION STAGE

1st step:

- Using the knife, make a specific cut in the body of the matapi, located between the two tongues. The window is the entry point for placing the bait and where the shrimp are also removed.
- Cut the window between the two tongues;
- Make a cut measuring 8cm by 8cm;
- Materials-
- Use a steel saw or knife;
- Use 6 12 cm long splints to make this little window;
- To tie the window, use two 65cm pieces of nylon.

DISCUSSIONS

Of the four phases of Reverse Didactic Engineering-EDR, the first of them was the definition of the training participants, leading to the 2nd phase, and a field agent was appointed, who was Mr. José. In view of this, after designating Mr. José as a specialist of the traditional practice of constructing the matapi, we then began the 3rd phase, which allowed questions and problematizations about the matapi, in which, thereby enabling the construction of a manual on how to make one (matapi).

This way, the construction of the Matapi transposed practice studied by the teachers, represented by P; agents from community A and study directors F, formed the class [F, A, P], under the direction of F, considering undefined school knowledge from what came before, instituted the didactic system S. Here the didactic system was instituted [S (P, A, F, Rm)] ➡ M Rm = {traditional knowledge} U {school knowledge} ➡ Ω' = Study manual for the construction of matapi

FINAL CONSIDERATIONS

Three models of matapis were built with the help of geogebra as shown in the manuals mentioned above. Its construction followed José's model of matapis, but modified in its structures (length, height, volume, distances between the splints, between the tongues, types of nylon), but preserved the materials used by the community under study, which are the Jupati splints, wild onion vines and agra chama, and the steps of construction in concrete, which reaffirms the need for masters in this process, because even if there is a textualized manual, traditional knowledge is as important as school knowledge for does not generate matapis panemas, proving the 4th phase of EDR.

Thus, there was a need to modify the initial model of the matapis built by José, because when we carried out the tests, they captured both large and small shrimp, which in the future could compromise the disappearance of shrimp in the place. Thus, the new models from Geogebra confirmed the research already carried out by Araújo, et al. (2014) and Costa (2016), capturing large shrimp and saving the small ones. This seeks to achieve environmental balance in the community of ``Pacuí de Cima``, who lives from shrimp fishing, as his constructions were made with 4mm and 5mm nylon.

Therefore, these new models highlighted the internal didactic transposition (CHEVALLARD, 2009a) when we problematize the matapi, it made us develop questioning attitudes about the existence of the matapi panema. Ultimately, the success of the course depended greatly on the use of geogebra, considering that it allowed experiments on the construction of matapis that would be difficult for teachers to achieve with just "pencil and paper".

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