

Design of interactive mathematical tasks that make up the reasoning and the Ethnomathematics program

Jonathan Alberto Cervantes-Barraza , Armando Aroca Araujo* 

Mathematics Education Department, Universidad del Atlántico, Atlántico, Colombia
*Correspondence: armandoaroca@mail.uniatlantico.edu.co

Received: 28 February 2023 | Revised: 1 May 2023 | Accepted: 9 June 2023 | Published Online: 16 June 2023
© The Author(s) 2023

Abstract

The design of mathematical tasks has taken the replacement on the research agenda of Mathematics Education. In this article, we provide principles of design of interactive mathematical tasks that make up the reasoning and the Ethnomathematics program. The research context involved the design, the development, and the analysis of written and oral prospective mathematics teacher (PMT) in an initial training course. The methodology implemented was descriptive-interpretative and implicated the design of mathematical tasks by the PMTs based on the adaptation of the HiCuA analytical framework. Regarding to the analysis of the data collected, categories of mathematical task types were constructed because of a thematic analysis carried out with the purpose of characterizing the tasks designed by the prospective teacher. The findings of the study provide information on the design principles implemented by prospective teacher in the context of Reasoning and Ethnomathematics. Likewise, it was identified that promoting reasoning and Ethnomathematics through interactive mathematical task designs supports students by developing skills such as: justifying, criticizing, and reasoning the conclusions presented by others.

Keywords: Future Professors, Mathematics, Reasoning, Rebuttal, Task

Cite: Cervantes-Barraza, J. A., & Araujo, A. A. (2023). Design of interactive mathematical tasks that make up the reasoning and the Ethnomathematics program. *Journal on Mathematics Education*, 14(3), 469-482. <http://doi.org/10.22342/jme.v14i3.pp469-482>

In the curricular of Mathematics Education, the relevance and pertinence of studies which encourage students' reasoning in classrooms are appreciated (e.g., Cervantes-Barraza & Cabañas-Sánchez, 2022; Cabañas-Sánchez & Cervantes-Barraza, 2019). Reasoning as a transversal competence in mathematics learning supports in the communicating answers by justifying conclusions, connecting previous concepts with new ones and the refutation, students' reasoning can be faced with the purpose of convincing others of the truthfulness of the conclusions presented in the collective (Cervantes-Barraza & Cabañas-Sánchez, 2022).

The research has yielded the role of teacher in the argumentative process is crucial, since the planning and the management of the class provides opportunities for students to build arguments, validate them and build conclusions (Solar, Ortiz, Deulofeu, & Ulloa, 2021; Cervantes-Barraza, Cabañas-Sánchez, & Mercado-Porrás, 2020). Regarding to the previous, Solar et al. (2021) stated that to encourage participation and discussion in mathematics classes, teachers should consider from the lesson plan the promotion of students' arguments and prospective teacher need to be trained to develop reasoning skills by specifying the type of questions to be used in order to encourage the construction of knowledge when solving mathematical tasks. In this research, a mathematical task means "situations

teacher propose (problems, investigations, exercises, etc.) to students. These are the starting point of the student's activity, which at the same time, produces as a result their learning" (Pochulu, Font, & Rodriguez, 2016, p.76). Research based on promoting the reasoning in the classroom suggested the necessity of including technology in the process of mathematical task design, these using videos, mobile applications, geometry software's (Cervantes-Barraza & Vargas-Delgado, 2022).

Under this perspective, one of the occupations of the mathematics teacher is the adaptation and the design of tasks that are developed in class with students (Godino, 2013), the content of the tasks sometimes refers to a given context that involves delimiting which mathematical processes and knowledge supports learning based on contextualized situations close to the student (Aroca, 2022; Zambrano & Samper, 2017; Ayalon & Even, 2016). Researchers note that teachers' knowledge and their practice influence mathematics learning (Llinares, 2014), according to this, Groenwald and Llinares (2019) highlight the need to reflect during the training of the future mathematics professor (PMT) with the idea of improving basic teaching competencies, such as: the professional teaching gaze (Ivars, Fernández, & Llinares, 2019), didactic analysis (Godino, 2013); reasoning management in the classroom (Solar & Deulofeu, 2016) and mathematical task design (Cabañas-Sánchez & Cervantes-Barraza, 2019; Cervantes-Barraza & Vargas-Delgado, 2022).

According to D'Ambrosio (2014), the founder of Ethnomathematics, he refers to the term as the mathematics practiced by cultural groups, such as urban and rural communities, by groups of workers, professionals, children, indigenous societies, and others who identify themselves by common goals or traditions. In this sense, when talking about ethnomathematics we refer to those activities carried out in the close and visible context of everyone, where aspects related to mathematics are involved in one way or another. Pioneering researchers of the Ethnomathematics program, Aroca (2022) and Huru, Räisänen, and Simensen (2018) suggest that mathematical task designs based on the analysis of cultural artifacts used in cultural practices have the potential to support the learning of mathematics, language, and culture. D'Ambrosio (2008a) defines the word Ethnomathematics as the following:

The ethnomathematical word, as I conceive it, is made up of three roots: ethno, and by ethno I understand the various environments (or social, or cultural, nature, and everything else); mathema meaning explain, understand, teach, lidarcom; tica, which names the word aggregatecné, which refers to arts, techniques, manners. Therefore, synthesizing these roots, temosetno+mathematics+ethics, ouetnomathematics, which, therefore, means the set of arts, techniques of explaining and understanding, of lidarcom or social, cultural, and natural environment, developed by different cultural groups (p. 8).

In the same way, D'Ambrosio (2001) states that Ethnomathematics is the area of education that seeks to reflect on the mathematical knowledge that is generated from the interaction in a particular cultural group. Wiryanto, Primaniarta, and de Mattos (2022) argue that,

The environment surroundings are full of values and knowledge from culture, professional activities, and an entire experience contributing to a re-signification of mathematical concepts. Many contents of academic mathematics are presented in our daily tasks, such as buying in supermarkets, producing, and selling products, working, and cultural activities (p. 662).

A synthesis of the literature review allowed identifying the adherent problem linked to the training courses of future mathematics teacher. What interactive mathematical tasks do future mathematics



teachers design that promotes the construction of arguments in students and the analysis of cultural practices, given that including the design of sequences of mathematical tasks in the programs and activities that a teacher will have to carry out when in the classroom becomes an opportunity to boost the learning of mathematics (Montes et al., 2019; Groenwald & Llinares, 2019). Thus, how the knowledge that teacher use in their practice is important to encourage students' understanding from the design of mathematical tasks (Ivars, Fernández, & Llinares, 2019). In this regard, Cervantes-Barraza, and Vargas-Delgado (2022) and also Watson and Ohtani (2015) point out the importance of the study of the design of mathematical tasks, the implementation, and the development of them make easier the learning of mathematics. However, there are few studies that address from the training of the future mathematics teacher, the design of interactive mathematical tasks based on design principles, specially, research that help to the design of tasks that boost the build of arguments by students in mathematics classes based on the analysis of daily practices performed by cultural groups from the northern coast from Colombia. Therefore, the main goal of this research is to contribute to the design principles of interactive mathematical tasks that make up the Reasoning and the Ethnomathematics.

METHODS

Regarding to the development of this research, a descriptive qualitative approach was introduced with the purpose of identifying the content of mathematical tasks and the principles used by a group of Future Mathematics Teacher (PMT) in the context of reasoning (Bikner, Knipping, & Presmeg, 2015). The research question that leads the study is: what interactive mathematical tasks do future mathematics teacher design that promotes the construction of arguments in students and the analysis of cultural and practices? this question was drawn from the following hypotheses: the implementation and development of mathematical tasks based on design principles, specially, to develop the construction of arguments by students in mathematics classes based on the analysis of daily practices performed by cultural groups from the northern coast from Colombia promote the learning of mathematics.

The PMT Training Course

A training course for future mathematics teacher entitled "Design of interactive mathematical tasks based on principles of the reasoning and Ethnomathematics" was developed with the goal of strengthening conceptual aspects of future mathematics teacher for the design of mathematical tasks in the context of Mathematics Education. The training course was developed under the modality of a diploma course offered to students of the last semester of the degree program in mathematics and was developed in 5 modules taught by teacher assigned to the previous programs, each module required 20 hours of theoretical-practical class. In this matter, the module designed to address the training course linked to research demanded 5 sessions of 3 hours per day and 5 extra hours of analysis and reflection about what was learned. The design of the course was based on theoretical and methodological steps presented in Cervantes-Barraza and Vargas-Delgado (2022).

Participants and Colombian Context

Twenty future mathematics professors participated in the training course during two academic semesters (2022-1 and 2022-2). The participants were students academically enrolled in the last semester of the bachelor's degree mathematics program at a public university in northern Colombia, and academically achieved all the academic credits required by the program to obtain the degree of bachelor in mathematics. It should be noted that, to the purposes of ethics and the care of the information, we talk



about to each of the participating PMT with the letter P accompanied by a natural number belonging to each participant (P1, P2, P3, ..., P20). The participants were in their last semester of the bachelor's degree program in mathematics at a public university located on the northern coast from Colombia.

Over their training in the bachelor's degree program, future teacher was selected by using a non-statistics method, we introduced the criteria of those future teacher that received classes and addressed didactic, pedagogical, and school mathematics contents and at the same time are enrolled in the training course. The same size in not selected by statistics methods, so we create a selection process to sign the twenty future mathematics teachers with the best average in the accumulate calcifications. Participants age were from Twenty to Twenty-eight years old, 12 were female and 10 males. The ethnicity of participant was variable due to some of them were from urban regions and some of them from rural ones, these last ones come from Colombian afro ethnicity.

The Colombian Caribbean coast is one of the poorest regions of Colombia, and with the least population concentration in rural areas due to the exploitation of land through extensive cattle farming (Meiseil & Pérez, 2006). Throughout its history, it has suffered land dispossession and displacement due to the violence that has characterized the country. Paradoxically it is also a very happy region, full of festivals and carnivals and traditional children's games that are still preserved. The Colombian Caribbean region is located in the north of the country. It consists of nine departments and 194 municipalities. The economic base of the Caribbean region is varied, agriculture, livestock, mining, industry, tourism, and maritime transport stand out. It is a region with a hot climate and that has a diverse range of craft trades, whose mathematics used has been analyzed in Aroca (2009) on the backpack designs of the Arhuaca indigenous community of the Sierra Nevada de Santa Marta, in Nieto, Araújo and Vasquez (2019) on the artisan elaboration of cassava buns, in Morales Beleño and Aroca-Araujo (2020) on the designs of Usiacurí handicrafts; in Paternina-Borja, Muñoz-Granados, Pacheco-Muñoz and Aroca-Araújo (2020) on the design of the Barranquilla carnival masks, among other investigations.

Designing Interactive Mathematical Tasks: The Analytical Framework

An interactive mathematical task is defined as the set of activities, exercises, problem situations proposed by the mathematics professor based on a learning goal, hypothetical learning trajectories, a slogan, several questions that trigger the construction of arguments and refutations designed with the help of digital technological tools such as Genially, Canva, and Padlet, among others. In addition, D'Ambrosio (2014) stated that the Ethnomathematics Program is a research program, which focuses on the origin, transmission, and structures of a community or of a particular subject, all this oriented towards knowledge, which is it adapts to epistemology, sociology, history, politics, cognitive science, and education. Costa (2015) states the following:

D'Ambrosio proposes, then, that the students, by means of mathematics, be brought to mathematize real situations, be competent in the construction of theories appropriate to the situations and the problems that come up. It seems that the real picture of mathematical teaching shows more or structuralism and formalism that persists as based on engineering and less, or referentialism to regionalities, to cultural diversity. The holistic principle of education guides D'Ambrosio's theorizations, in which knowledge is a maturation between different dimensions, such as intuitive, sensory, emotional, and rational, which cannot be separated (p. 4).

According to the previous quote, it can be inferred that students should be led to visualize the



mathematics that people perform in their daily lives in order to link knowledge between theory and practice, that is, for an adequate design of mathematical tasks.

The methodological foundation of this research is based on the adaptation of the HiCuA analytical framework proposed by Huru, Räsänen, and Simensen (2018) (Figure 1), which means the steps for the design of mathematical tasks based on cultural activities and can be applied in the context of mathematics teaching. The theoretical framework is about 3 phases, (1) identifying artifacts or traditional knowledge, (2) designing mathematical tasks, and (3) implementing mathematical tasks. The adaptation of the analytical framework (HiCuA) (see Figure 1) was about including audiovisual material such as ethnomathematics videos meaning to the cultural practices performed by farmers, employees, commoners when employing cultural practices in the context of mathematics designed by one of the authors of this research (see more at: <https://www.youtube.com/@matematicasdelpueblo.peopl7235>).

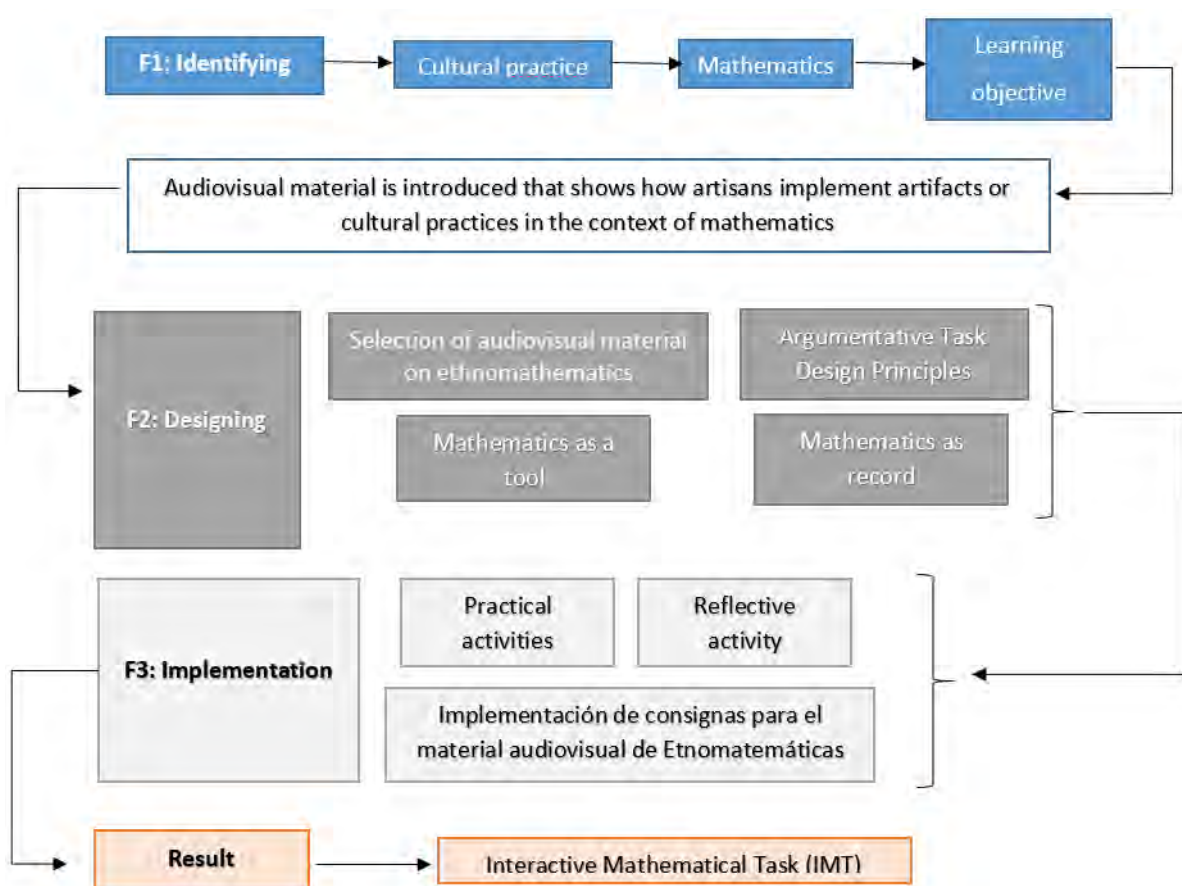


Figure 1. Adaptation of the phases of the HiCuA analytical framework proposed by Huru, Räsänen, and Simensen (2018, p.129).

The academic channel has more than 345 videos of ethnomathematics and FMT used 22 videos for each interactive task designed. Plus, videos are included to support and promote the construction of arguments based on the principles of mathematical task design: Level of cognitive demand, Formulation of the task, and Management of confrontation of positions (Cabañas-Sánchez & Cervantes-Barraza, 2019). The principle of ethnomathematics that were included to design interactive mathematical task were: Teacher takes over the important role of developing instructions that aim to connect the identifying, cultural practice with the mathematics, and teacher should plan how to best support students'

mathematics and language learning according to the intended learning objectives (D'Ambrosio, 2008b).

In phase 1, identification, the teacher, preferably together with the artisans, identifies an object, such as a traditional artifact and/or knowledge, to base the task or lesson on. Simultaneously, the chosen object is analyzed with respect to the mathematical knowledge and learning objectives involved in designing, using and/or working with this object. The learning objectives of the curriculum are then chosen with respect to the mathematical and linguistic aspects relevant to the chosen object (Huru, Räisänen, & Simensen, 2018).

Phase 2 describes four aspects of the task design process. In this phase, the teacher designs the task in collaboration with the craftsmen. We are aware that students' work with learning activities intended for mathematics does not always encourage students to use and learn mathematics. We suggest that the teacher takes on the important role of developing instructions that aim to connect the boxes in phase 1 with the boxes in phase 2. More precisely, the teacher should in phase 3 plan how to best support students' mathematics and language learning according to the intended learning objectives (Huru, Räisänen, & Simensen, 2018).

The implementation of the design task, phase 3. Students, teachers work together with the chosen object based on the learning objectives and, for example, stories, traditions, and identity. This phase will typically consist of both hands-on and reflective activities, and the teacher has an important role in encouraging students to engage in mathematical meaning-making processes when working on the culture-based topic/object (Huru, Räisänen, & Simensen, 2018).

At phase 1, identification, teacher, ideally along with the artisans, identifies an object, such as a traditional artifact and/or knowledge, to base the task or lesson on. At the same time, the chosen subject is analyzed with respect to the mathematical knowledge and learning objectives involved in designing, using and/or working with this subject. The learning objectives of the curriculum are then chosen regarding to the mathematical and linguistic aspects relevant to the chosen object (Huru, Räisänen, & Simensen, 2018).

At phase 2 describes four aspects of the task design process. In this phase, teacher design the task in collaboration with the craftsmen. We are aware that students' work with learning activities intended for mathematics doesn't always encourage students to use and learn mathematics. We suggest the teacher takes over the important role of developing instructions that aim to connect the boxes at phase 1 with the boxes at phase 2. Specifically, teacher should at phase 3 plan how to best support students' mathematics and language learning according to the intended learning objectives (Huru, Räisänen, & Simensen, 2018).

The implementation of the design task, phase 3. Students, teacher work together with the chosen subject based on the learning objectives and, for example, stories, traditions, and identity. This phase will typically consist of both hands-on and reflective activities, and the teacher has an important role in encouraging students to engage in mathematical meaning-making processes when working on the culture-based topic/object (Huru, Räisänen, & Simensen, 2018).

Analysis of the Designed Tasks

The data of this research is the set of interactive mathematical tasks designed by future mathematics teacher, in order to gather the task, the instrument was used as a digital survey designed by a Google form where FMT upload the interactive task using a form of word. The analysis of the interactive mathematical tasks was carried out based on thematic analysis (Braun & Clarke, 2012). Thematic analysis involves six phases, at phase 1: Familiarization with data. The researcher becomes familiar with the data collected in



the research, interactive mathematical tasks. Phase 2: Coding. Labels or possible categories are generated that show characteristics of the tasks designed by the future teacher such as: justification tasks, conjecture tasks, tasks from a statement, research tasks and argumentative tasks. At phase 3. Searching for themes, the principles of task design are introduced as subjects in which labels or categories that were generated from the coded data relevant to each subject are part of (Clarke & Braun, 2013).

Phase 4, Review subjects. To allowed and to interweave and ensure each of the codes, categories with subjects, and the types of mathematical tasks identified. Phase 5. To define and name subjects, delves into each of the themes or principles of designs found as: the level of cognitive demand, refers to two levels, high and low, the high level refers to the student's ability to interpret and analyze mathematics. At the low level, students provide answers by repeating formulas and reasoning to algorithmic procedures (Smith & Stein, 1998). The formulation of the task highlights how the teacher poses the tasks to the student, either in pencil and paper or technological, depending on the context in which it is found (Guzman & Romero, 2015). Argument confrontation management refers to the refutations of the students caused by the questions presented by the teacher (Solar & Deulofeu, 2016). Reasoning requires students to explain and justify their conclusions and the classroom management has to do with the teacher's operations before the answers during the development of the tasks.

And finally, at phase 6: Writing. A final report is written that includes the categories found as justification tasks, characterized by visualizing, exploring, comparing, checking, and mixing figures or following a certain pattern to get a mathematical conclusion.

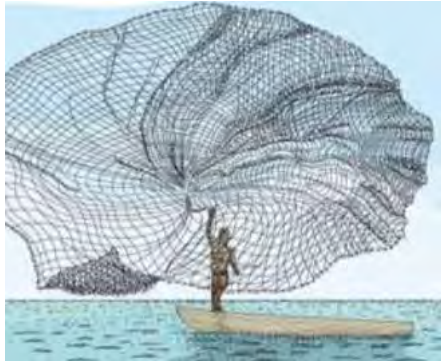
RESULTS AND DISCUSSION

The future teachers were requested to design a sequence of three interactive mathematical tasks (IMT) based on the audiovisual material selected from the YouTube channel PeopleMath, in order to put the HiCuA methodology into operation. In a group of two participants, they designed a sequence of 3 mathematical tasks (see <https://view.genial.ly/629d6aa9c3f6e3001109061e/presentation-erick-gutierrez-siller-arrieta>) in which the first group formed by P1 and P2 showed the design of mathematical tasks related to the artisanal practice of fishing and the location of points in the Cartesian plane (see Table 1). The design principles used were the low cognitive demand level and the management of the confrontation of positions. In this context, finding of this research help to the design principles of interactive mathematical tasks that make up the reasoning and the ethnomathematics, to do that, we present the different type of mathematical task designed by FMT and discussed about the content and the relevance.

The research results are the result of the thematic analysis lead on the task designs presented by prospective mathematics teacher in the context of designing mathematical tasks that improve students' construction of arguments. To identify how prospective teacher designed mathematics tasks, five categories were established with respect to the design principles implemented. Categories (C) of mathematical tasks designed in the training course were identified, justification tasks (C1), tasks from statements (C2), argumentative tasks (C3), conjectural tasks (C4), and research tasks (C5).



Table 1. Initial mathematical task designed by a group of FPM at the end of the training course

Mathematics task (initial moment)	
Grade:	Sixth
Mathematics content:	Geometry
Thought:	Metric special
DBA/Standard:	Recognizes the Cartesian plane as a two-dimensional system that allows locating points as a graphic or geographic reference system.
Aim:	Locate, describe, and represent the position and trajectory of a subject in a Cartesian plane.
Context:	Students must have knowledge of the concepts of abscissa, ordinate and Cartesian plane, point, line, and distance
Slogan 1:	<p>According to the following points A (3,4) and B (-3,-4) when graphing the points, we got the following graph, build an isosceles triangle using the two points mentioned above, in which quadrant is the third point located? Is the abscissa in the quadrant where the third point is located positive or negative?</p> 
Hypothetical learning trajectory	<ol style="list-style-type: none"> 1. 1. H1 Students draw segment AB 2. 2. H2 Students find the distance of segment AB 3. 3. H3 Since an isosceles triangle must be constructed; students must construct another segment from A to P or from B to P. 4. 4. H4 Segment AP or BP must have the same distance from AB 5. 5. H5 You must trace the segment either PB or PA 6. 6. H6 Construct the isosceles triangle APB or ABP
Task solution	<p>P1(9,-4); P2(3,-6); P3(-7,4); P4(-5,-2)</p> <p>These are the points that students must obtain if they have others, they will be valid as well</p>
Required time:	60 minutes
Design principles implemented:	<ul style="list-style-type: none"> ● Level of cognitive demand ● Argument confrontation management

Based on the thematic analysis carried out, a synthesis of the results of each of the PMT groups that designed the interactive mathematical tasks is compiled. [Table 2](#) summarizes the constituent elements of the IMTs designed at the end of the training course.

Table 2. Synthesis of the interactive mathematical tasks and their characteristics

Group	Aim	Slogan	Principle (ρ)	IMT
(P1, P2)	Locate, describe, and represent the position and trajectory of an object in a Cartesian plane.	It relates elements of culture such as fishing to contextualize the location of points on the Cartesian plane.	The p1 and p3 are included at the beginning of the sequence, then the p1, p2 and p3 are combined.	https://view.genial.ly/629d6aa9c3f6e3001109061e/presentation-erick-gutierrez-siller-arrieta <i>Tasks based on statements (C2)</i>
(P3, P4)	Identify the elements that make up geometric shapes and bodies and use their dimensions to solve everyday situations.	They raise the slogans based on food, circular-shaped objects that surround the students and their cultural context.	They consider the three principles p1, p2 and p3 in the design of the task sequence with the purpose of promoting argumentation.	https://view.genial.ly/629e24259077230018061a15/presentation-presentacion-pizarra <i>Argumentative tasks (C3)</i>
(P5, P6)	Identify and calculate percentages using rational numbers in their different expressions (decimal fractions and percentages) to solve problems in the context of measurements.	They resort to situations of hairstyles typical of the Afro culture and the calculation of percentages related to the necessary elements in the hairstyle.	For the first task they only resort to exploration and argumentation without including the principles. Then in the other tasks they include p2 and p3 to promote refutation and argumentation.	https://view.genial.ly/629aa24e1dd32d0018c7fe50/presentation-diseno-de-tarea-porcentajes <i>Conjecturing task (C4)</i>
(P7, P8)	Identify geometric figures, lines, segments, and angles by means of a ladder made of graduation.	Relate elements of culture such as the construction of stairs to contextualize Thales' theorem.	A narrative of situations is made, and the arguments are confronted: this with the objective of generating analysis and construction by the student that will serve to reinforce learning in classes about Thales' theorem.	https://view.genial.ly/629d37497dccb50019bbbce2/presentation-presentacion-geometria-bicolor <i>Justification tasks (C1)</i>
(P9, P10)	Recognize relationships between numbers (being multiple or divisor) in different contexts.	Properties of numbers (being even, being odd, etc.) and relationships between them (being greater than, being less than, being a multiple of, being divisible by, etc.) are recognized in different contexts.	They consider the three principles p1, p2 and p3 in the design of the task sequence with the purpose of promoting argumentation.	https://view.genial.ly/629b9b186b6512001846da29/presentation-presenstacion-juego-siglo <i>Research tasks (C5).</i>

The tasks performed by teachers in training are constituted of justification tasks that according to Zambrano and Samper (2017), promoting explanations to mathematical processes such as: to compare,



to visualize and to check. The tasks that belong to this first category involve questions with open or closed answers, without including a statement or initial information, however, Inprasitha, Changsri, and Boonsena (2020), note that through open questions it is possible to promote mathematical arguments. The different type of task designed in this study is established into categories C1, C2, C3, C4, C5, they are a synthesis of what a mathematics teacher are able to design by using the principles of argumentation and ethnomathematics, this is an opportunity to promote the learning of mathematics using and promoting mathematical competences like reasoning, connecting, refuting and representing (Cervantes-Barraza & Cabañas-Sánchez, 2022; Rumsey & Langrall, 2016; Yackel, 2002).

Among the notorious characteristics of the design of interactive mathematical tasks, the relationship between the learning objectives, the instructions, hypothetical learning trajectories and the principles used. We recognize the goals proposed in the task sequences are agree with the level of cognitive demand, since the first task seeks exploration and arguments as cognitive activities that promote the build of knowledge (Pedemonte & Balacheff, 2016; Conner, 2008). According to this, the design of tasks is considered as an important perspective to achieve a quality teaching in the process of initial and continuous training of mathematics teacher. According to Barreiro, Leonian, Marino, Pochulu and Rodriguez (2017), a task is organized by three parts: the slogan, to emphasize the statements teacher present to students, the context refers about what and how classes work and goals, also refers on what teacher want students to learn in class. In words of Barreiro et al. (2017), Cervantes-Barraza and Cabañas-Sánchez (2022) and contrasting with findings a mathematical task promotes in students the exploration and reasoning of solutions of situations, to establish judgments, to reflect and to argue the selected answer.

CONCLUSIONS

The answer to the research question is the task designs presented by prospective mathematics teachers in the context of designing mathematical tasks that improve students' construction of arguments. They designed different type of identified mathematics' tasks, justification tasks, tasks from statements, argumentative tasks, conjectural tasks, and research tasks. In this research, it was identified teacher in training design mathematical tasks from a previous knowledge or a concept previously learned by students, according to Yeo (2007) these tasks request students to know the theoretical elements and strategies necessary to solve it. Types of tasks, which guided the analysis of those designed by the future teachers, have been photographed. The conjecture tasks (based on the task designs of the teachers in training), provide the formulation of a conjecture or supposition that reflects the mathematical relation that exists when exploring a situation based on a determined context, a unique case, the tasks designed from a statement, provide evidence about how teacher in training create an introductory statement that provides information or data and allows students to solve the task, regard to this, Guzmán and Romero (2015), state out the formulation of the task involves a context and previous information that places students in producing a conclusion as a solution. Argumentative tasks were identified in a statement where students must analyze and argue the answer they present as a solution, according to Silva Calderón (2013), argumentative tasks motive the construction of conclusions and reasons that seek to explain or justify the solution of the task including conceptual components.

Considering Carneiro (2021), the design of tasks from this point of view that has been handled in the article, builds conditions of ethnomathematical connections for the student: "Teaching mathematics in this conception will allow the student to link the concepts that they work in class with their daily



experience, according to their natural, social, and cultural environment. It is not about rejecting academic mathematics, but about incorporating values that are experienced in group experiences, considering historical-cultural ties” (p.3). As mentioned by Rodríguez-Nieto et al. (2022), mathematical connections and ethnomodeling are characterized by relating mathematics developed by cultural groups and institutionalized mathematics.

It is also recognized that part of teacher' training is to characterize the principles of mathematical task designs; where it was evidenced that justification tasks, tasks from a statement and research tasks possess greater frequency in students for teachers who participated in the study, managing to identify in those the design principles that at the same time agree with the reasoning and demand students to justify and present mathematical conclusions. Additionally, teacher influence listening and promote students to criticize, to affirm and to justify different reasoning, demonstrating that all of these are built based on argumentation (Ayalon & Hershkowitz, 2018). In this sense, the main objective of the Ethnomathematics Program is to propose a broader vision of knowledge and human behavior, making sense of how different communities, societies, and civilizations faced their struggle for survival and transcendence in their environment, cultural, economic, and social contexts (D'Ambrosio & Knijnik, 2020).

Based on the results obtained in the research, it is recommended to adapt the mathematical tasks in terms of justification, conjecture, from statements, research and argumentative, these support teacher to strengthen the planning of the class and manage to promote with brief criteria mathematical argument is, the development of skills such as justifying, criticizing, and refuting the conclusions or reasoning of the students. Furthermore, it is necessary to research more about the design of mathematical tasks and how can be designed from cultural aspects.

Acknowledgments

This research was founded by the internal call for the strengthening of the research groups of the Universidad del Atlántico, filed with project number: CED380-PS2022.

Declarations

- Author Contribution : JAC-B: Conceptualization, Writing - Original Draft, Editing and Visualization.
AAA: Writing - Review & Editing, Formal analysis, and Methodology.
- Funding Statement : This research was funded by Universidad del Atlántico, Barranquilla, Colombia.
- Conflict of Interest : The authors declare no conflict of interest.

REFERENCES

- Aroca, A. (2009). *Geometría en las mochilas arahuacas. Por una enseñanza de las matemáticas desde una perspectiva cultural*. Cali: Editorial Universidad del Valle.
- Aroca, A. (2022). Un enfoque didáctico del programa de Etnomatemáticas. *Tecné, Episteme y Didaxis: ted*, 52, 211-248. <https://doi.org/10.17227/ted.num52-13743>
- Ayalon, M., & Even, R. (2016). Factors shaping students' opportunities to engage in argumentative activity. *International Journal of Science and Mathematics Education*, 14, 575-601. <https://doi.org/10.1007/s10763-014-9584-3>



- Ayalon, M., & Hershkowitz, R. (2018). Mathematics teachers' attention to potential classroom situations of argumentation. *The Journal of Mathematical Behavior*, 49, 163-173. <https://doi.org/10.1016/j.jmathb.2017.11.010>
- Barreiro, P., Leonian, P., Marino, T., Pochulu, M. D., & Rodríguez, M. A. (2017). *Perspectivas metodológicas en la enseñanza y en la investigación en educación matemática* (2da ed.). Prov. de Buenos Aires, Argentina: Ediciones UNGS.
- Bikner, A. A., Knipping, C., & Presmeg, N. (2015). Approaches to Qualitative Research in Mathematics Examples of Methodology and Methods. *Advances in Mathematics Education*. <https://doi.org/10.1007/978-94-017-9181-6>
- Braun, V., & Clarke, V. (2012). Análisis temático. In P. M. n H. Cooper, *APA handbooks in psychology. APA handbook of research methods in psychology*, 2. Research designs: Quantitative, qualitative, neuropsychological, and biological. *American Psychological Association*, 57-71 <https://doi.org/10.1037/13620-004>
- Cabañas-Sánchez, G., & Cervantes-Barraza, J. A (2019). Principios que fundamentan el diseño de tareas matemáticas en una planificación didáctica. *Uno Revista de Didáctica de las Matemáticas* (85), 7-12.
- Carneiro, R., Toscano, J., & Díaz, J. (2021). *Los desafíos de las TIC para el cambio*. Fundación Santillana.
- Cervantes-Barraza, J. A., Cabañas-Sánchez, G., & Mercado-Porras, K. (2020). *El rol del profesor en la construcción de conocimiento matemático a través de la argumentación colectiva*. In H. Hernández, J. Juárez, J. Slisko (Eds.). PP. 214-2.
- Cervantes-Barraza, J. A., & Cabañas-Sánchez, M. G. (2022). Argumentación matemática basada en refutaciones. *REDIMAT –Journal of Research in Mathematics Education*, 11(2), 159-179. <https://doi.org/10.17583/redimat.4015To>
- Cervantes-Barraza J. A., & Vargas-Delgado, L. (2022). Concepciones de futuros profesores de matemáticas en el diseño de tareas argumentativas. *Universidad Autónoma del Caribe. Revista Encuentros*, 20(02). <https://doi.org/10.15665/encuentro.v20i02>
- Clarke, V., & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The Psychologist*, 26(2), 120-123.
- Conner, A. (2008). Expanded Toulmin diagrams: a tool for investigating complex activity in classrooms. En O. Figueras, J. Cortina, S. Alatorre, T. Rojano, & A. Sepúlveda (Eds.). *Proceedings of International Group for the Psychology of Mathematics Education* (Vol 2, pp. 361-368). México, Morelia.
- Costa, F. J. M. da. (2015). *Etnomatemática: metodologia, ferramenta ou, simplesmente, etnorevolução?* *Zetetike, Campinas, SP*, 22(2), 181–196. <https://doi.org/10.20396/zet.v22i42.8646571>
- D'Ambrosio, U., & Knijnik, G. (2020). *Encyclopedia of Mathematics Education* (second edition). Stephen Lerman Editor. DOI: <https://doi.org/10.1007/978-3-030-15789-0>
- D'Ambrosio U. (2001). *Etnomatemática – elo entre as tradições e a modernidade*. Coleção Tendências em Educação Matemática, 1. Belo Horizonte: Autêntica



- D'Ambrosio, U. (2008a). *Etnomatemática. Entre las tradiciones y la modernidad*. México: Limusa.
- D'Ambrosio, U. (2008b). O Programa Etnomatemática: uma síntese [El Programa de Etnomatemáticas: una síntesis]. *Acta Scientiae*, 10 (1), 112- 115. <https://revistas.ucr.ac.cr/index.php/cifem/article/view/49181/48952>
- D'Ambrosio, U. (2014). Las bases conceptuales del Programa Etnomatemáticas. *Revista Latinoamericana de Etnomatemáticas*, 7(2), 100-107.
- Godino, J. D. (2013). Diseño y análisis de tareas para el desarrollo del conocimiento didáctico-matemático de profesores. *Actas de las Jornadas Virtuales en Didáctica de la Estadística, Probabilidad y Combinatoria*, 1-15.
- Guzmán, P. G., & Romero, I. (2015). Enseñar las matemáticas escolares. (eds.): Pablo Flores Martínez, Luis Rico Romero. *Enseñanza y aprendizaje de las matemáticas en Educación Primaria*. 61-87.
- Groenwald, C. L., & Llinares, S. (2019). Competencia docente de observar con sentido situaciones de enseñanza. *Revista Paradigma*, 40(1), 29-46. <https://doi.org/10.37618/PARADIGMA.1011-2251.2019.p29-46.id740>
- Huru, H. L., Räisänen, A.-K., & Simensen, A. M. (2018). Culturally based mathematics tasks: a framework for designing tasks from traditional Kven artefacts and knowledge. *Nordic Studies in Mathematics Education*, 23(3-4), 123–142.
- Inprasitha, M., Changsri, N., & Boonsena, N. (2020). *Proceedings of the 44th Conference of the International Group for Psychology of Mathematics Education*. Khon Kaen, Thailand: PME.
- Ivars, P., Fernandez, F., & Llinares, S. (2019). Principles in the Design of Tasks to Support Preservice Teachers' Noticing Enhancement. En M. Graven, H. Venkat, A. Essien y P. Vale (Eds.). *Proceedings of the 43rd Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 408-415). Pretoria, South Africa: PME.
- Llinares, S. (2014). Experimentos de enseñanza e investigación. Una dualidad en la práctica del formador de profesores de matemáticas. *Educación Matemática*, 31-51.
- Meiseil, A., & Pérez, G. (2006). *Geografía física y poblamiento en la Costa Caribe colombiana*. Bogotá: Banco de la República de Colombia.
- Montes, M., Climent, N., Carrillo, J., & Contreras, L. (2019). Constructing tasks for primary teacher education from the perspective of Mathematics Teachers' Specialised Knowledge. *Eleventh Congress of the European Society for Research in Mathematics Education*, Utrecht University, Feb 2019, Utrecht, Netherlands. fhal-02430479f
- Morales Beleño, M., & Aroca-Araujo, A. (2020). Deconstrucción del diseño, un análisis a la base del diseño de las artesanías de Usiacurí. *Revista Latinoamericana De Etnomatemática Perspectivas Socioculturales De La Educación Matemática*, 12(2), 6-28
- Nieto, C. A. R., Araújo, A. A. A., & Vasquez, F. M. R. (2019). Procesos de medición en una práctica artesanal del caribe colombiano. Un estudio desde la etnomatemática. *Revista Latinoamericana de Etnomatemática*, 12(4), 41-68. <https://doi.org/10.22267/relatem.19124.36>

- Paternina-Borja, O., Muñoz-Granados, N., Pacheco-Muñoz, E., & Aroca-Araújo, A. (2020). Simetrías inmersas en el proceso de la elaboración de la máscara del torito de Galapa. *Rev. Investig. Desarro. Innov.*, 11(1), 141-157. <https://dx.doi.org/10.19053/20278306.v11.n1.2020.11689141>
- Pedemonte, B., & Balacheff, N. (2016). Establishing links between conceptions, argumentation and proof through the $ck\phi$ -enriched Toulmin model, *Journal of Mathematical Behavior*, 41, 104–122.
- Pochulu, M., Font, V., & Rodríguez, M. (2016). Desarrollo de la competencia en análisis didáctico de formadores de futuros profesores de matemática a través del diseño de tareas. *Revista Latinoamericana de Investigación en Matemática Educativa*, 19(1), 71-98. <http://dx.doi.org/10.12802/relime.13.1913>
- Rodríguez-Nieto, C. A., Nuñez-Gutierrez, K., Rosa, M., & Orey, D. C. (2022). Conexiones etnomatemáticas y etnomodelación en la elaboración de trompos y tacos de carne. Más allá de un antojito mexicano. *Revemop*, 4, e202202. <https://doi.org/10.33532/revemop.e202202>
- Rumsey, C., & Langrall, C. W. (2016). Promoting mathematical argumentation. *Teaching Children Mathematics*, 22(7), 413-419. <https://doi.org/10.5951/teacchilmath.22.7.0412>
- Silva Calderón, L. H. (2013). Argumentar para definir y definir para argumentar (Tesis de maestría). *Universidad Pedagógica Nacional*, 134.
- Smith, M. & Stein, M. (1998). Selecting and creating mathematical task, from research to practice. *Mathematics Teaching in the Middle School*, 3(5), 344-350.
- Solar, H., & Deulofeu, J. (2016). Condiciones para promover el desarrollo de la competencia de argumentación en el aula de matemáticas. *Bolema*, 30(56), 1092-1112. <https://doi.org/10.1590/1980-4415v30n56a13>
- Solar, H., Ortiz, A., Deulofeu, J., & Ulloa, F. (2021). Teacher support for argumentation and the incorporation of contingencies in mathematics classrooms. *International Journal of Mathematical Education in Science and Technology*, 52(7), 977-1005. <https://doi.org/10.1080/0020739X.2020.1733686>
- Watson, A., & Ohtani, M. (2015). Themes and issues in mathematics education concerning task design: Editorial introduction. In A. Watson y M. Ohtani (Eds.), *Task design in mathematics education: An ICMI study 22* (pp. 3–15). New York: Springer
- Wiryanto Primaniarta, M. G., & de Mattos, J. R. L. (2022). Javanese ethnomathematics: Exploration of the Tedhak Siten tradition for class learning practices. *Journal on Mathematics Education*, 13(4), 661-680. <http://doi.org/10.22342/jme.v13i4.pp661-680>
- Yackel, E. (2002). What we can learn from analyzing the teacher's role in collective argumentation. *Journal of Mathematical Behavior*, 21(4), 423–440. [https://doi.org/10.1016/S0732-3123\(02\)00143-8](https://doi.org/10.1016/S0732-3123(02)00143-8)
- Yeo, J. B. (2007). Mathematical tasks: Clarification, classification, and choice of suitable tasks for different types of learning and assessment (Reporte técnico ME2007-01). *Mathematics and Mathematics Education technical report series*. <https://repository.nie.edu.sg/bitstream/10497/949/3/MathematicalTasks.pdf>
- Zambrano, J., & Samper, C. (2017). *Tareas que promueven la argumentacion matemática*. En P. Perry (ed). Encuentro de Geometría y sus Aplicaciones, 23, 99-104. 198764065

