ISSN: 1815-7696 | RNPS: 2057 | Mendive. Journal on Education. Vol. 24, e4737
Fernández Chavesta, J. M.; Esteban Espinoza, D.; Ricaldi Echevarría, M. L. "Didactic strategy for teaching mathematical functions in the context of exports".
https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/4737

2026

Original article

Didactic strategy for teaching mathematical functions in the context of exports

Estrategia didáctica para la enseñanza de funciones matemáticas en el contexto de exportación

Estratégia didática para o ensino de funções matemáticas no contexto da exportação

Juan Manuel Fernández Chavesta[1] 0000-0001-5466-6586 jfernandezch@unife.edu.pe
David Esteban Espinoza[1] 0000-0001-8025-6409 davidestebane@unife.edu.pe
Myrian Luz Ricaldi Echevarría[1] 0000-0003-4251-0562 myrianricaldie@unife.pe

[1] Women's University of the Sacred Heart. Peru.

Received: 14/08/2026
Accepted: 1/11/2026

ABSTRACT

The teaching of mathematical functions in business degree programs tends to favor abstract procedures disconnected from professional situations, which limits their usefulness for business decision-making and reduces students' motivation. In Peru, the dynamism of the export sector offers real contexts that can be used to give meaning to these contents. The objective was to design a didactic strategy for teaching mathematical functions in the context of product exports. The methods used were a qualitative approach with an action-research design, direct and indirect observation, focus groups and documentary analysis of official statistical sources on foreign trade. Thirteen female students in the fourth cycle of the International Business Administration program, aged between 17 and 21, took part, and the observation and focus group guides were validated through expert

judgement. The results show a strategy structured in four phases: identification of the export situation, data analysis, mathematical modelling and reflection. The students selected exportable Peruvian products, such as alpaca-fiber sweaters and beans, and identified suitable destination markets; with the support of spreadsheets and GeoGebra, they built the total cost, revenue and profit functions and determined the break-even point. The conclusions indicate that the strategy fosters an understanding of the meaning of linear functions in real business situations, integrates technological resources into the modelling process and strengthens students' ability to interpret results and justify export-related decisions; it is therefore a viable alternative for mathematics education in international business programs.

Keywords: didactic strategy; mathematical functions; mathematical modelling; exports; higher education.

RESUMEN

La enseñanza de las funciones matemáticas en las carreras de negocios suele privilegiar procedimientos abstractos desvinculados de las situaciones profesionales, lo que limita su utilidad para la toma de decisiones empresariales. En el Perú, el dinamismo del sector exportador ofrece contextos reales que pueden aprovecharse para dotar de sentido a estos contenidos. El objetivo estuvo dirigido a diseñar una estrategia didáctica para la enseñanza de funciones matemáticas en el contexto de la exportación de productos. Como métodos se utilizaron el enfoque cualitativo con diseño de investigación-acción, la observación directa e indirecta, los grupos focales y el análisis documental de fuentes estadísticas oficiales sobre comercio exterior. Participaron 13 estudiantes del cuarto ciclo de la carrera de Administración de Negocios Internacionales, y los instrumentos fueron validados mediante juicio de expertos. Los resultados muestran una estrategia estructurada en cuatro fases: identificación de la situación de exportación, análisis de datos, modelación matemática y reflexión. Las estudiantes seleccionaron productos peruanos exportables, como chompas de fibra de alpaca y frejol; construyeron, con apoyo de hojas de cálculo y GeoGebra, las funciones de costo total, ingreso y utilidad, y determinaron el punto de equilibrio. Como conclusiones se plantea que la estrategia favorece la comprensión del significado de las funciones lineales en situaciones empresariales reales, integra los recursos tecnológicos al proceso de modelación y fortalece la capacidad de las estudiantes para interpretar resultados y argumentar decisiones vinculadas con la exportación; lo que constituye una alternativa viable para carreras de negocios.

Palabras clave: estrategia didáctica; funciones matemáticas; modelación matemática; exportación; educación superior.

RESUMO

O ensino das funções matemáticas nos cursos de negócios costuma privilegiar procedimentos abstratos desvinculados das situações profissionais, o que limita sua utilidade para a tomada de decisões empresariais. No Peru, o dinamismo do setor exportador oferece contextos reais que podem ser aproveitados para dar sentido a esses conteúdos. O objetivo foi elaborar uma estratégia didática para o ensino de funções matemáticas no contexto da exportação de produtos. Como métodos, foram utilizados a abordagem qualitativa com desenho de pesquisa-ação, a observação direta e indireta, os grupos focais e a análise documental de fontes estatísticas oficiais sobre comércio exterior. Participaram 13 estudantes, com idades entre 17 e 21 anos, do quarto ciclo do curso de Administração de Negócios Internacionais, e os instrumentos foram validados por meio de julgamento de especialistas. Os resultados mostram uma estratégia estruturada em quatro fases: identificação da situação de exportação, análise de dados, modelagem matemática e reflexão. As estudantes selecionaram produtos peruanos exportáveis, como suéteres de fibra de alpaca e feijão; construíram, com o apoio de planilhas eletrônicas e do GeoGebra, as funções de custo total, receita e lucro, e determinaram o ponto de equilíbrio, que no caso dos suéteres situou-se em aproximadamente 434 unidades. Como conclusões, aponta-se que a estratégia favorece a compreensão do significado das funções lineares em situações empresariais reais, integra os recursos tecnológicos ao processo de modelagem e fortalece a capacidade das estudantes de interpretar resultados e argumentar decisões vinculadas à exportação, constituindo uma alternativa viável para a formação matemática em cursos de negócios internacionais.

Palavras-chave: estratégia didática; funções matemáticas; modelagem matemática; exportação; educação superior.

INTRODUCTION

Over the past two decades, Peru has experienced sustained export growth, driven largely by agricultural exports of products such as asparagus, blueberries, avocados, and onions, several of which the country ranks among the world's leading suppliers. This dynamism has expanded business opportunities and, consequently, the demand for professionals capable of analyzing costs, revenues, and profitability using quantitative criteria. University education in international business, therefore, faces the challenge of integrating mathematical content with the decisions its graduates will need to make in the job market.

However, mathematics education in business programs conventionally emphasizes logical construction and procedural mastery over its application to real-world business situations. This separation leads students to perceive mathematics as a subject unrelated to their profession. Gil-Doménech and Berbegal-Mirabent (2020) showed that when business students seek economic applications of mathematical concepts studied in class, learning becomes meaningful, and both technical and transversal skills are developed. Similarly, Jiménez-Murillo *et al.* (2022) used mathematical modeling to analyze the variation in income of rice producers in Ecuador, demonstrating the potential of functions to describe real-world economic problems.

Mathematical modeling has become established as one of the most fruitful ways to link school and university mathematics with real-world applications. Kaiser and Sriraman (2006), in their review of international perspectives on modeling, identified several approaches that share the purpose of using extra-mathematical situations to promote the understanding and application of knowledge. Subsequent empirical research has confirmed that modeling can be taught and learned, although it requires careful instructional design and sustained teacher support (Schukajlow *et al.*, 2018). Likewise, the systematic review of Cevikbas *et al.* (2022) shows that the development of modeling skills depends on authentic tasks, collaborative work, and explicit opportunities for validation and reflection.

From a theoretical perspective, Biembengut and Hein (1997) proposed a framework that connects reality and mathematics through stages of interaction, mathematization, and modeling. Subsequently, Blum and Leiß (2007) developed a modeling cycle focused on the cognitive processes students undertake, from understanding the situation to validating the results, and Borromeo Ferri (2006) specified the phases of this process based on empirical evidence of how students move

between them. Maaß (2006), for his part, characterized modeling competencies as a set of sub-competencies that include understanding the real-world problem, constructing a model, solving it mathematically, and interpreting and validating the solution.

In higher education, Camarena (2015) proposed the theory of mathematics in the context of science, which highlights the importance of contextualizing mathematical content within the disciplines studied by future professionals. Fontana and Groenwald (2023) proposed a modeling cycle that facilitated the identification and resolution of real-world organizational problems with university students, using computational technologies, and Aravena *et al.* (2022) demonstrated that combining case studies and mathematical modeling contributes to developing STEM skills in engineering education.

Technological resources play a significant role in these proposals. Juandi 's meta-analysis *et al.* (2021) concluded that GeoGebra-assisted learning has a positive effect on mathematical performance, a result that coincides with Zulnaidi 's study *et al.* (2020). More recently, Wardat *et al.* (2023) analyzed the use of ChatGPT in the teaching and learning of mathematics and warned that, along with its potential, this tool presents limitations in the accuracy of its responses, which requires a critical assessment of the results it generates.

Despite these advances, there are few teaching proposals that use export activity as a context for teaching mathematical functions in international business programs, even though this context is particularly relevant in export-oriented economies like Peru's. This lack limits students' opportunities to understand the meaning of cost, revenue, and profit functions in authentic professional situations.

Therefore, the objective of this study was to design a didactic strategy for teaching mathematical functions in the context of product export.

MATERIALS AND METHODS

The study was conducted using a qualitative approach, aimed at understanding an educational problem and introducing improvements in teaching practice. A non-experimental action research design was employed, developed in cycles of diagnosis, planning, action, and reflection, which allowed for the active collaboration of the participants in modeling roles within business contexts.

Thirteen female students in their fourth semester of the International Business Administration program, aged 17 to 21, participated in the study. Inclusion criteria were enrollment in the Mathematics for International Business course and providing informed consent. Students who did not belong to the institution, semester, or academic area, as well as those who voluntarily declined to participate, were excluded. Participation was voluntary, and confidentiality was guaranteed; only the participants' first names are used in the article.

Direct and indirect observation, as well as focus group interviews, were used to collect the information. The instruments, consisting of observation guides and interview guides for the focus groups, were designed by the authors and validated through expert review. Observation allowed for recording the students' performance during each phase of the strategy, while the focus groups gathered their assessments of the modeling process and the usefulness of the functions for analyzing product exports.

A documentary analysis was also conducted. The 2022 Annual Report of the Central Reserve Bank of Peru was examined. This official document reports on the evolution of Peruvian foreign trade and indicates that the value of exports increased from approximately US$7 billion to over US$66 billion in a 22-year period, a roughly 9.5-fold increase, primarily due to agricultural exports. Additionally, the databases of the Exportemos.pe platform and the National Superintendency of Customs and Tax Administration (SUNAT) were consulted. Students obtained information from these databases on Peruvian export products, their destination markets, volumes, and prices. These documents were used as sources of real-world data for designing the learning activities, not as theoretical frameworks.

The collected data were processed using Microsoft Excel spreadsheets and GeoGebra software, with additional support from artificial intelligence tools. Qualitative information from observations and focus groups was organized into categories corresponding to the phases of the teaching strategy, allowing for a description of the process followed by the students and an evaluation of the results of its application.

RESULTS

Teaching strategy (Figure 1)

Identification of products to export: competitive export products were identified, with the support of a database to analyze product demand and market value. Institutionally, challenges and gaps are identified in the multisectoral area for the economic development of the sectors.

Data analysis: The collection of selective data using spreadsheets, computer programs, scientific calculators, and software; which allowed for improved optimization and handling of the data.

Modeling: Fixed costs (salaries, electricity, water, telephone) and other variable costs (fixed cost per unit of production) were calculated to determine the total cost. This was done using a single standard monetary unit, estimated exportable kilograms and tons. Subsequently, mathematical models were generated for total cost, profit, and redesigned revenue streams using technology.

Reflection: Students discuss the process of product identification, data collection and analysis, and the modeling performed, thus reinforcing their understanding of the export process and the mathematical model.

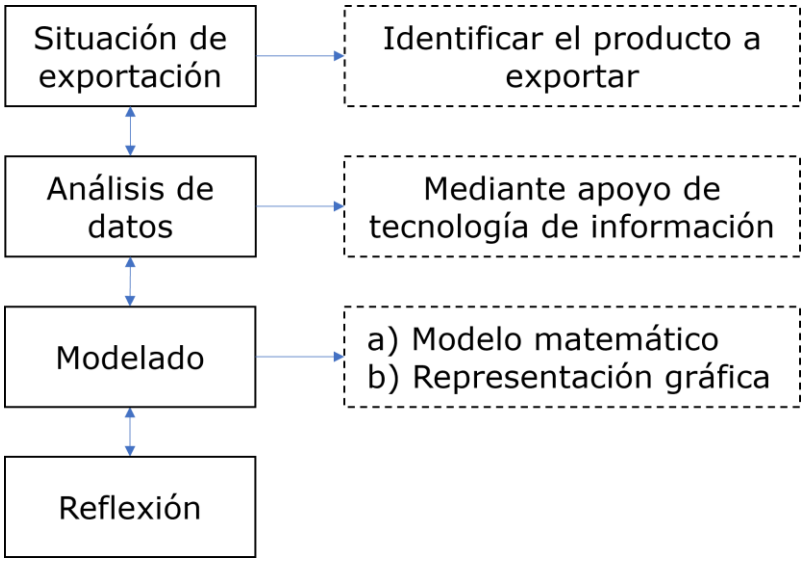


Figure 1. Diagram of the didactic strategy

Export situation

The students identified Peruvian export products using databases from institutions such as Exportemos.pe and Sunat (National Superintendency of Customs and Tax Administration), in order to obtain detailed information about the products, their target markets, export volumes, and other relevant data (Figure 2).

Selected products and processes: export of pink potatoes, sweaters with alpaca fiber, export of Peruvian pisco and export of beans.

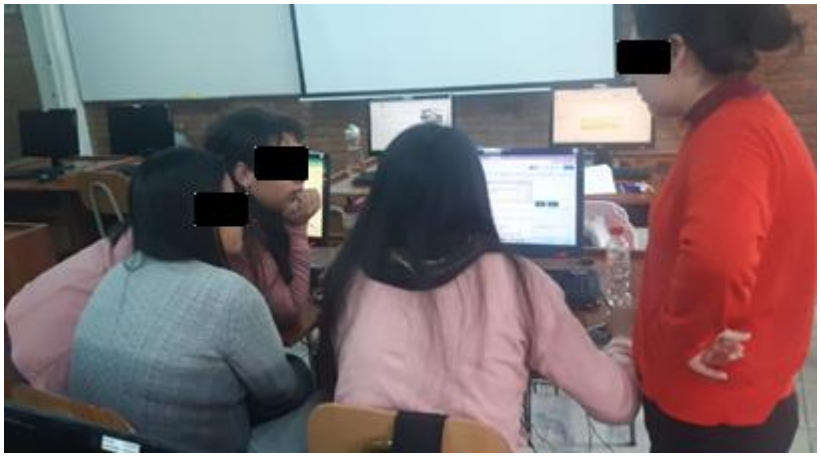


Figure 2. Students selecting the product
Source: Image taken by the researchers

Data analysis: the collected data were processed using tools such as: spreadsheets and specialized software for modeling and numerical analysis, such as Microsoft Excel or with the support of artificial intelligence tools (Figure 3).

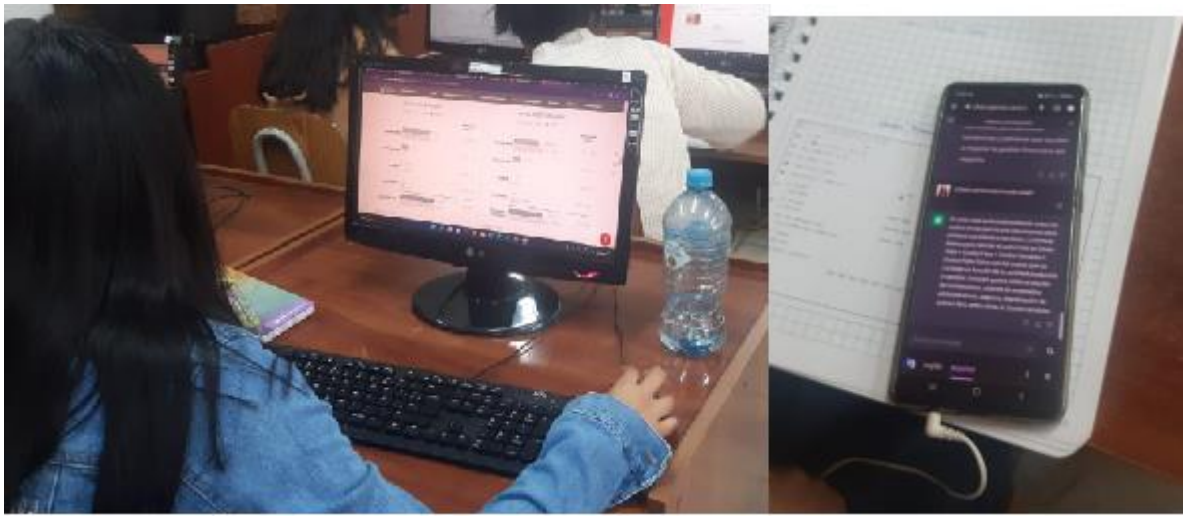


Figure 3. Students analyzing the data

Source: Image taken by the researchers

Modeling

Product 1: Sweaters with alpaca fiber

Students: Sarah, Maria Angelica, Summy, Angela and Sheyde generate the fixed cost, production cost per unit and model the total cost for the product (Tables 1, 2 and 3).

Table 1. Fixed cost for the production of sweaters with alpaca fiber

Cost of services per 1000 garments made (Electricity and water)	Payment to workers (per 1000 garments made)	Cost of material (per 1000 garments)	Fixed cost per production of 1000 garments
S/ 120	S/ 25,000	S/ 65,250	S/ 90 370

Source: Own elaboration

Table 2. Production cost per unit of sweaters with alpaca fiber

Production cost per garment	Conversion of final cost to euros (approximate)
S/ 111 per unit	Approximately €27.80 per unit

Source: Own elaboration

Table 3. Modeling total cost for "n" products produced from sweaters with alpaca fiber

Selling price (per unit)	Convert (euros to soles)	Total cost of the company (model)
Destination: Germany Currency: Euros Trending regular price: €80 per sweater	€80 = S/319.20	Total Cost = 90370 + 111n

Source: Own elaboration

Regarding the export destination of the product, the students stated: "The destination to which the product will be exported is Germany. Chosen for its high demand for alpaca garments and favorable climate for its use".

In order to generate the model of the monthly income of the product, the students carry out the following sequence: per unit, the regular price of an alpaca sweater for men is €80 which, converted to soles, results in an approximate S/319.20.

Projected sales of 1000 units

$$I(x) = 319.20n$$

$$I(n) = 319.20(1000)$$

$$I(n) = 319\ 200$$

The monthly income obtained from selling 1000 alpaca sweaters is S/319,200.

*Revenue = Selling price * units sold*

*I(x) = Pv * n*

I(x) = 80n

1 euro = 3.99 soles

I(n) = 319.20n; n ≥ 0

Regarding monthly profit, the students plan to detail the model, based on the number of units produced and sold. The mathematical model allows them to determine the profit for "n" units produced and sold.

Profit = Revenue - Total Cost

U(n) = I(n) – Ct (n)

U(n) = 319.20n - (90370 + 111n)

U(n) = 208.2n - 90370; n ≥ 0

Product 2: Bean export

Students: Janet, Flavia, Fabiana (Table 4).

Table 4. Partial costs to determine the fixed cost

Store	monthly	1900 soles
Transport	daily (15 days a month)	500–600 soles
Paying workers	17 workers	60 soles
Light	monthly	100 soles
Seeds	1 bag (25 kg)	1000 soles
Land	Payment for 6 months	5000–6000 soles
Buying beans	1 kg	3 soles
The transport is used 15 times per month	15×500	7500 soles
Land rental per month	5000/6	833.3 soles
Total payment to workers	2580	
Purchase of the seeds	1000	
Buying beans	1,115,200	

The production cost per 1 kg of beans is S/ 1.8

Total cost = fixed cost + variable cost

Tc = 12013.3 + 1.8x

The destination for exporting the product is the United States. We chose this country because there is high demand and consumption of beans.

The selling price of beans per kg in the United States is $4.37

Monthly income 16.34 x

Monthly profit for "x" products produced and sold

Profit = Revenue – Total Costs

U(x) = 16.34x –(12 013 + 1.8x) = 14.54x - 12 013

Students use Geogebra to create visual representations of the generated mathematical models: total cost, revenue, and profit (Figures 4 and 5).

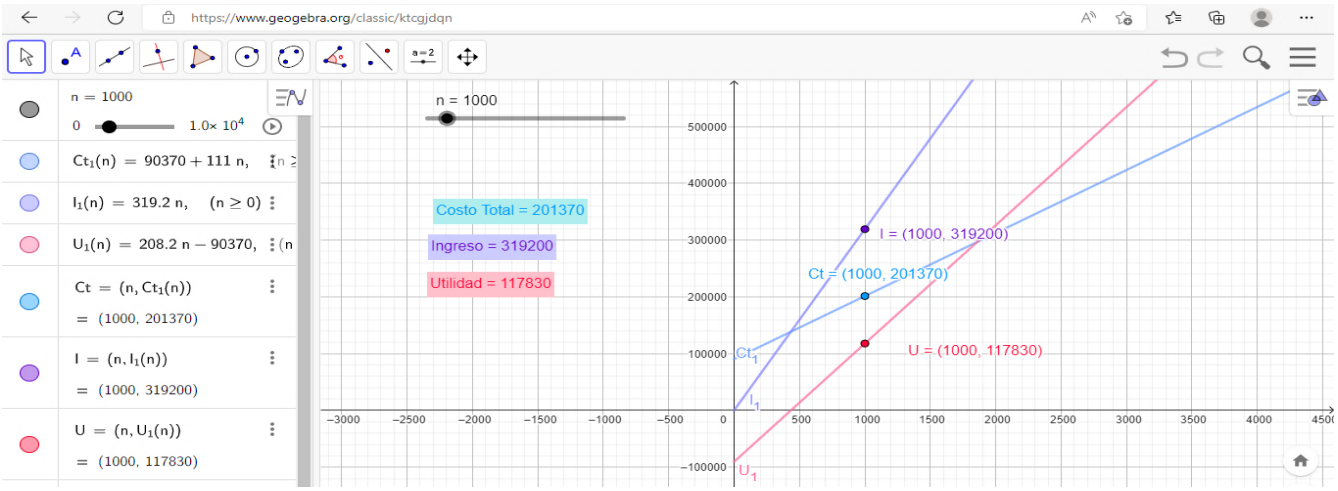


Figure 4. Graphical representations of total cost, revenue and profit prepared by the members of group 1

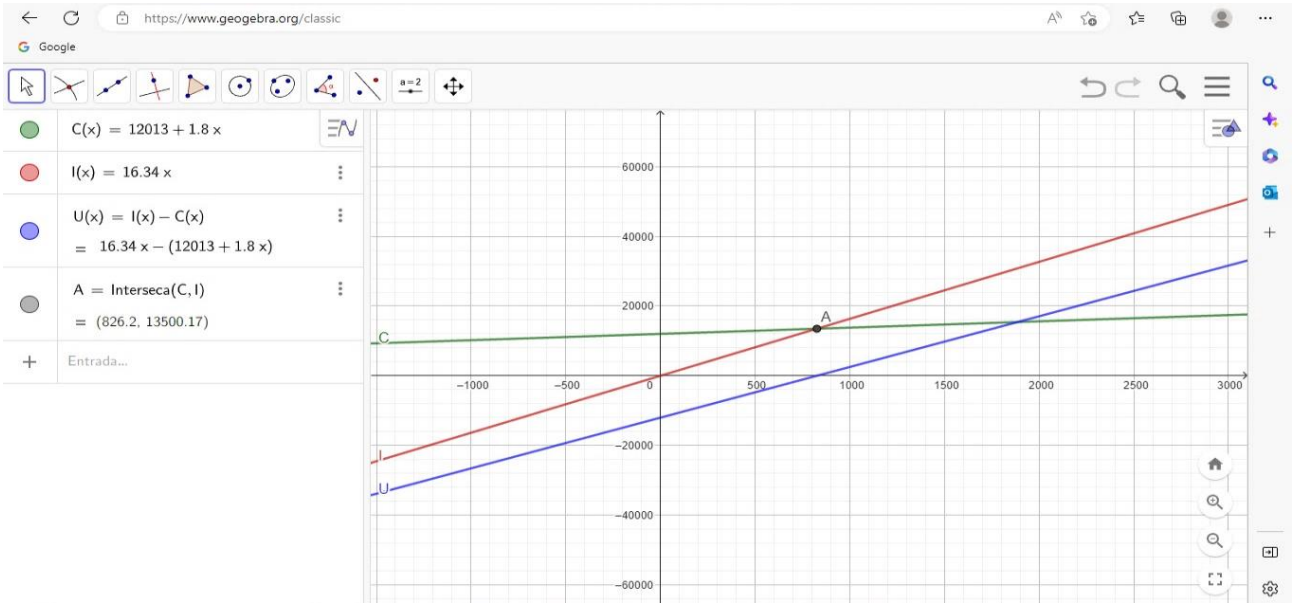


Figure 5. Graphical representations of total cost, revenue and profit prepared by the members of group 2

Group reflection

Group 1. (Product: alpaca sweater)

When dealing with the export of garments made from Alpaca fiber, focusing solely on the product "standard men's sweaters in plain weave", which was chosen due to the ease of direct contact with the exporter Juan Carlos.

Thanks to the data collected during the interview, we were able to identify the variables mentioned above, which will help us determine the total cost, profit, and revenue functions.

Furthermore, this activity allows us to recognize the international value of a garment made from alpaca fiber in our country. Similarly, it enables us to identify the various fixed and variable costs involved in garment production, analyze the different functions, and represent them using GeoGebra and Excel. These tools will provide us with a clearer understanding of the functions related to cost, profit, and revenue. Additionally, it allows us to evaluate the profit and loss of this business in order to analyze the profitability of our intended exports.

Regarding the calculations carried out throughout this research, it can be stated that the break-even point is approximately 434 units, where total revenue equals total cost. However, to generate profits, sales must exceed 434 units, as sales below this amount would result in significant losses for the company.

Based on the above, it is concluded that Germany is identified as a strategic target market for the export of the product due to its economic stability and growing demand that can be capitalized on.

Group 2. (Product: beans)

As a group, we concluded that an exported product has greater demand abroad. Furthermore, the analysis of the number of products sold reveals that there is neither profit nor loss; there is both profit and loss.

We are interested in finding the number of units produced and sold, for which there is neither profit nor loss.

$$I(x) = CT(x)$$
$$16.34x = 12\,013 + 1.8x$$
$$16.34x - 1.8x = 12\,013$$
$$14.54x = 12\,013$$
$$x = 12\,013/14.54$$
$$x = 826.2$$

Therefore, losses occur when less than 826 kg of beans are produced and sold per month; this happens because total revenue is less than the total cost of production. Conversely, profits occur when more than 826 kg are produced and sold, and this happens because total revenue is greater than the total cost of production.

DISCUSSION

The didactic strategy designed in this research proposes a structured sequence that begins with the identification of an export situation using real-world data, continues with the analysis of that data and mathematical modeling, and concludes with critical reflection on the results. This sequence essentially coincides with the modeling cycles described by Biembengut and Hein (1997) and by Blum

and Leiß (2007), which begin with understanding a real-world situation and culminate in the interpretation and validation of the model. The main difference lies in the fact that, in this proposal, the initial situation is not provided by the teacher, but rather constructed by the students themselves through the selection of an exportable product, thus increasing their involvement in the task.

The product identification phase allowed students to recognize goods with export potential through information analysis and the use of technological resources. This result aligns with the findings of Gil-Doménech and Berbegal-Mirabent (2020), who discovered that exploring economic applications of mathematical concepts makes their learning meaningful for business administration students. Similarly, it corresponds to Camarena's (2015) theory of mathematics within the context of science, which posits that mathematical content acquires meaning when linked to the specific problems of the profession.

In the modeling phase, the students progressed from identifying variables such as fixed costs, unit production cost, and selling price to constructing total cost, revenue, and profit functions, and determining the break-even point. This progression reflects the modeling sub-competencies described by Maaß (2006), particularly model construction, mathematical solution, and interpretation of the results in a real-world context. The difficulties observed in some calculations, such as currency conversion and the aggregation of partial costs, align with the findings of Borromeo Ferri (2006), who demonstrated that students do not progress through the cycle phases linearly, but rather return to previous stages to correct and refine their models.

The results are also consistent with those of Fontana and Groenwald (2023), who, working with problem situations in real organizations within higher education, found that modeling promotes meaningful learning and decision-making. Similarly, the experience aligns with that of Aravena *et al.* (2022), whose work with case studies and mathematical modeling in engineering education characterized the development of STEM skills, and with Jiménez-Murillo *et al.* (2022), who demonstrated the usefulness of mathematical models for analyzing the income of agricultural producers. Taken together, these studies and the present proposal indicate that linear functions constitute an accessible and powerful tool for economic analysis when taught within authentic contexts.

The use of spreadsheets and GeoGebra facilitated data processing and the graphical representation of total cost, revenue, and profit functions, allowing students to visualize the break-even point and

the profit and loss zones. This finding aligns with Juandi 's meta-analysis. *et al.* (2021) and with the study by Zulnaidi *et al.* (2020), who reported positive effects of using GeoGebra on mathematical performance. On the other hand, the support of artificial intelligence tools in data analysis raises the need for teachers to guide the critical verification of their results, as Wardat points out. *et al.* (2023) in their study on the use of ChatGPT in mathematics teaching.

The reflection phase proved crucial for the students to interpret the meaning of the constructed models. In their evaluations, the groups linked the break-even point to the viability of the business and justified their choice of target market based on demand and the economic conditions of the importing country. This result aligns with Huincahue 's findings. *et al.* (2018), who highlight the role of reflection in the construction of knowledge about mathematical modeling, and with the review by Cevikbas *et al.* (2022), which identifies validation and reflection as essential components for the development of modeling skills.

International empirical research warns, however, that modeling is demanding for both students and teachers, and that its benefits depend on careful instructional design and sustained support (Schukajlow *et al.*, 2018). In this sense, the proposed strategy offers an explicit sequence of phases that can guide teaching, although its application in other contexts will require adapting the export situations to the students' interests and the available resources. Kaiser and Sriraman (2006) emphasize that the different perspectives on modeling respond to diverse educational purposes; in this case, the predominant purpose is pragmatic and formative, oriented towards business decision-making.

Limitations of the study include the small number of participants, all women from the same institution, and the qualitative nature of the design, which does not allow for generalizing the results or establishing the strategy's effect on academic performance. Future research could apply the strategy with larger and more diverse groups, incorporate measurements of the development of modeling skills, and compare its effect with that of other teaching methods.

In summary, the designed teaching strategy fosters an understanding of the meaning of mathematical functions in real-world business situations, integrates technological resources into the modeling process, and strengthens students' ability to interpret results and justify decisions related to exporting. Therefore, it constitutes a viable alternative for mathematical training in international business programs.

REFERENCES

Aravena, M. D., Díaz, D., Rodríguez, F., & Cárcamo, N. (2022). Estudio de caso y modelado matemático en la formación de ingenieros. Caracterización de habilidades STEM. *Ingeniare. Revista Chilena de Ingeniería*, *30*(1), 37-56. https://doi.org/10.4067/S0718-33052022000100037

Biembengut, M., & Hein, N. (1997). Modelo, modelación y modelaje: métodos de enseñanza-aprendizaje de matemáticas. *Epsilon: Revista de la Sociedad Andaluza de Educación Matemática "Thales"*, (38), 209-222. https://dialnet.unirioja.es/servlet/articulo?codigo=166725

Blum, W., & Leiß, D. (2007). How do students and teachers deal with modelling problems? En C. Haines, P. Galbraith, W. Blum, & S. Khan (Eds.), *Mathematical modelling: Education, engineering and economics* (pp. 222-231). Woodhead Publishing. https://doi.org/10.1533/9780857099419.5.221

Borromeo Ferri, R. (2006). Theoretical and empirical differentiations of phases in the modelling process. *ZDM*, *38*(2), 86-95. https://doi.org/10.1007/BF02655883

Camarena, P. (2015). Teoría de las ciencias en contexto y su relación con las competencias. *Ingenium*, *16*(31), 108-127. https://doi.org/10.21500/01247492.1370

Cevikbas, M., Kaiser, G., & Schukajlow, S. (2022). A systematic literature review of the current discussion on mathematical modelling competencies: State-of-the-art developments in conceptualizing, measuring, and fostering. *Educational Studies in Mathematics*, *109*(2), 205-236. https://doi.org/10.1007/s10649-021-10104-6

Fontana, A., & Groenwald, C. L. O. (2023). Meaningful learning and mathematical modelling: Contributions to dealing with business problem situations in higher education. *Acta Scientiae*, *25*(4), 62-94. https://doi.org/10.17648/acta.scientiae.7667

Gil-Doménech, M. D., & Berbegal-Mirabent, J. (2020). Making the learning of mathematics meaningful: An active learning experience for business students. *Innovations in Education*

and Teaching International, *57*(4), 403-412. https://doi.org/10.1080/14703297.2020.1711797

Huincahue, J., Borromeo-Ferri, R., & Mena-Lorca, J. (2018). El conocimiento de la modelación matemática desde la reflexión en la formación inicial de profesores de matemática. *Enseñanza de las Ciencias*, *36*(1), 99-115. https://doi.org/10.5565/rev/ensciencias.2277

Jiménez-Murillo, W., Garcés-Pérez, E., & Jiménez-Murillo, C. (2022). Aplicación de modelo matemático para la variación de ingresos de productores de arroz. La Troncal-Cañar. *Ciencia Latina Revista Científica Multidisciplinar*, *6*(1), 4824-4838. https://doi.org/10.37811/cl_rcm.v6i1.1834

Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Wijaya, T. T. (2021). A meta-analysis of GeoGebra software decade of assisted mathematics learning: What to learn and where to go? *Heliyon*, *7*(5), e06953. https://doi.org/10.1016/j.heliyon.2021.e06953

Kaiser, G., & Sriraman, B. (2006). A global survey of international perspectives on modelling in mathematics education. *ZDM*, *38*(3), 302-310. https://doi.org/10.1007/BF02652813

Maaß, K. (2006). What are modelling competencies? *ZDM*, *38*(2), 113-142. https://doi.org/10.1007/BF02655885

Schukajlow, S., Kaiser, G., & Stillman, G. (2018). Empirical research on teaching and learning of mathematical modelling: A survey on the current state-of-the-art. *ZDM*, *50*(1-2), 5-18. https://doi.org/10.1007/s11858-018-0933-5

Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(7), em2286. https://doi.org/10.29333/ejmste/13272

Zulnaidi, H., Oktavika, E., & Hidayat, R. (2020). Effect of use of GeoGebra on achievement of high school mathematics students. *Education and Information Technologies*, *25*(1), 51-72. https://doi.org/10.1007/s10639-019-09899-y

Conflict of interest

Authors declare no conflict of interests.

Authors' contribution

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License