Conceptions of distance education and financial mathematics from an onto-historical understanding

L S Paz Montes¹, H M Parra López², and M Vergel Ortega³

¹ Departamento de Ciencias Administrativas, Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia
² Departamento de Sistemas e Informática, Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia
³ Departamento de Matemáticas y Estadística, Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia

E-mail: lpazmontes@gmail.com, mawency@ufps.edu.co

Abstract. Mathematics as a system of knowledge organized in distance education, in continuous expansion is applied in almost all disciplines of knowledge, is aimed at stimulating the development of cognitive skills, as well as analytical and critical skills, whose importance lies in the theory of value, seeks to discover manifestations to the development of the capacity for self-determination, collective autonomy and solidarity. The research was developed under the mixed paradigm, supported by a historical-dialectical and quantitative approach of confirmatory factor analysis, having as key informant’s managers, tutors, graduates and students of different programs of distance education. His ontology from the nature of the reality, was to generate a theoretical and didactic approach from the onto-historical understanding of financial mathematics in the trajectory of programs in distance education. The results obtained show that there is a significant relationship between the modality, the critical dialogical approach in the teaching of financial mathematics and technology. It is concluded that the conception of distance education is determined as an opportunity to be professional, for low-income youth who live in vulnerable areas, and have labour commitments. The structural model identifies factors, motivation, human relationships and resources, associated with the conception and development of cognitive skills in financial mathematics

1. Introduction

Distance education emerges as an alternative that surpasses the paradigm of the master student class in rigid spaces and time. The model it provides the opportunity of access to geographically dispersed groups with limited possibilities regarding the use of time, either by work, family or social reasons, offer the opportunity to learn to whoever wants it regardless of stratum, race, condition or age, overcomes distances and adapts to the availability and learning rhythms of students [1]. The historical development of open and distance education has shown that the media and the technological means available have been the main drivers of its evolution, dissemination and optimization, generating a culture of education and professionalization in order to achieve better conditions of quality of life and thus contribute to the progress of society in the estates that make it up at the local, national, regional and global levels [2]. In the context of distance education, financial mathematics emerges as a system of knowledge organized in continuous expansion, aimed at stimulating the development of cognitive skills and abilities, as well as analytical and critical skills, whose importance lies in the theory of value.
In the context frontier university, searched to discover, the manifestations and reasons for the obstacles that oppose teaching and learning regarding the development of self-determination capacity, collective autonomy and solidarity, and discover the possibilities of generating entrepreneurship to determine, project, perform and experience those teaching and learning processes. This raised the question: in what way can a theoretical, didactic approach be generated from the onto-historical understanding of financial mathematics in the trajectory of distance education? It was answered by identifying the conceptions of mathematics and distance education of students and tutors, contrast the theoretical-didactic references with the conceptions of tutors and students of distance education, and from a structural model, identify factors for the learning of financial mathematics in distance education.

The research addresses important aspects of an emergent nature, given the qualitative treatment printed throughout the study, it is thus possible to characterize the way in which, from its beginnings, distance education has allowed the development of teaching processes and learning, and how from them, project a vision of the need to reorient or reorganize the relevant processes, with a view to an education that adapts or responds in a better way to the requirements and demands of a society in which, together with knowledge in constant evolution, also, it faces the challenges that technology puts on the agenda for all the actors involved in the experience of participating in the construction of mathematical-financial knowledge, from each of the regions where individuals operate socially.

2. Methodology

From the nature of the present investigation, given the characteristics of the object of study and the context, together with the methodological perspective adopted to study it, the project is framed in the mixed approach since from the quantitative scope of the factorial analysis [3], from the qualitative field is located within the historical-dialectical approach, in which, from Hegel's idealistic dialectic, it offers three defined moments as the affirmation or thesis, the negation or antithesis and the negation of the negation or synthesis that can become a new thesis. The characteristic of the dialectical method is to consider historical and social phenomena in continuous movement, development and evolution from the economic-social structure. And from the historical point of view, the analysis of documents and records referring to the evolution of financial mathematics in distance education was made. In that order of ideas this method will deal with the nature of the problem, the personal experiences of the main actors, their attitudes and practices, as well as the characteristics of the context where it takes place, in whose inner core instruments are nested for a better analysis and interpretation of the results, from a more precise perspective. All this in order to guarantee confidence in the results as a faithful representation of what happens with the phenomenon studied [4].

For its part, the quantitative field will follow the correlation method, one that favors the relationship between variables. The factor analysis was based on conceptual assumptions obtained from conceptual historical analysis [3], generated structures of theoretical models and hypotheses tested empirically, without having previous specifications of the model or considering both the number of factors and the relationship between them. The technique used by the EFA is to extract the factors with certain statistical criteria, obtaining the simplest factor structure in terms of its easier and more meaningful interpretation. Once have the average values of each construct, as well as its standard deviation, analyzed the matrix of components, to determine 20 items that belong to each construct where the criterion of accepting those items whose value was greater than 0.5 [5]. The non-rotated factor matrix contains the factor loads, where each one represents the correlation of each original variable with the factors and indicate the degree of correspondence between each variable and factor. The research has a sequential design type with a group of 40 students of distance education and programs whose curriculum includes financial mathematics, 8 tutors and 3 managers in the border area Venezuelan’s. The subjects of these groups have not been assigned randomly, but through voluntary participation. The material used in the research was the in-depth interview and the survey; finally, was realized the triangulation of the obtained results.
3. Results

The onto-historical approach to distance education emerges with emerging categories of population with subcategory adults, rural and workers; policies and subcategories teacher training, coverage, professionalization, and resources with blended subcategories, cipas, virtually. The tendency in which it has been based has been the search of appropriate means of communication to offer learning possibilities to a greater number of people and with a greater degree of effectiveness, so it shows a remarkable evolutionary process from its first generation, “teleeducation (1950-1960)”, massive use of media in the 70s, interactive systems opened in the 90s, optimization of simulated technologies and media in the 21st century.

Distance education is conceived as the educational modality that allows students to develop their university studies with quality, without limitation of age, time and occupation. It is a way to prepare professionally with some flexibility since you can make use of information and communication technology (ICT). It is conceived in it, autonomous learning as the degree of student intervention in the establishment of objectives, procedures, resources, evaluation and learning moments, has a greater participation in their learning decisions, show that the culture student’s requires a semi-permanent presence to carry out its learning process, it is an alternative for people who work and because of their age they cannot access face-to-face education. Its purpose is to provide the opportunity to professionally train society and improve their quality of life.

The teaching of financial mathematics can be considered within a framework of globalization as a social construction in which the academic community participates actively in the development and maintenance of society over any type of frontiers. Money, study, rates, interest, finance, mathematical, financial, company, decisions, investments, credits, banking, financial, capital, set, methods, capital, economic, evaluation, calculate, values, level, visit, subject were included in the conceptions of the students of financial mathematics, contents contemplated in nuclear axes with scopes of knowledge of financial, economic, and business management, namely in economics, state, organizations, and in the social and human formation of young people, in which must have the capacity to problematize effectively. Mathematics as a system of organized knowledge, allows to model reality and use a logical sense to arrive at generalizations through symbolization. Consequently, it is aimed at stimulating the development of cognitive skills and abilities, which translates into analytical and critical capacities.

Financial mathematics involves the study and application of mathematics in making decisions of value in companies; applied especially in the economic-financial sector, banking, and all kinds of decisions involving money, rates, interest, time, credits, investments, performance, account management, and other operations, which allow the understanding, use of methods and tools for analysis, evaluation and decision making in finance. Results indicate that teaching is part of the constructivist and metacognition approach; with a method that encourages autonomous learning and application to life, where critical thinking is developed, mental skills through ICT, exhibitions and independent work guides. The evaluation is based on the evaluation of competences and diagnostic tests, training, includes both knowledge and skills through objective tests, and tests that measure the ability to meet demands according to the professional profile, mobilizing psychosocial resources. On the other hand, they perceive that representative strategies are formed by the autonomous work of the student, the effective and opportune accompaniment of tutors, a curriculum set up and analysed to carry out an effective process, reading and analysis of texts.

The didactic is based on the academic community of the distance modality, in the traditional approaches, it consists of the critical dialogical approach, the development of mental skills, autonomous learning, field work, metacognition is fostered using ICT as resources, exhibitions from the criticality and development of creative thinking. And the constructivist approach supported by the methodology of meaningful learning and development of competences in students, autonomous learning, field work. Faced with the evaluation, they consider that it should be done in laboratories focused on pedagogical practices; virtual, participatory, critical in which the student can consider their learning and the one exposed by the tutor, in works in groups, practical-theoretical and in round tables.
Analysing the structural model in the extraction method, observed in the Table 1, with eight main factors that explain approximately 80% of the variance. According to the factorial matrix, four important variables stand out: cognitive competences, motivation, human relations and resources. Chi-Square = 50.86, df = 32, P-value = 0.07405, Root mean square error of approximation (RMSEA) = 0.039. Given that the presented model has latent or unobserved variables, it is necessary to identify each of these with a statistical value in order to calculate the estimates of its effects. The estimated values evaluate a parameter that characterizes the population through a sample. For the estimated values in a model to be acceptable, they must have a load ≥ 0.07. The convergent validity or degree in which the indicators or items used to measure the latent variable are related to each other, is reached through significant standardized coefficients and greater than 0.5.

| Table 1. Factorial matrix.                          | Indicators                                   | Definition                                      | Weight |
|-----------------------------------------------------|----------------------------------------------|------------------------------------------------|--------|
| Construct                                           |                                               |                                                |        |
| Cognitive skills                                    | Attention                                    | Voluntary application of mental activity        | 0.874  |
|                                                    | Operational component                         | Analysis and logic in processes                 | 0.828  |
|                                                    | Study method                                 | Appropriate way to study                        | 0.866  |
|                                                    | Reading comprehension                         | Analysis of written texts                       | 0.853  |
|                                                    | Gender                                       | Set of people with similar characteristics      | 0.489  |
|                                                    | Family                                       | Set of people that is part of a marriage        | 0.485  |
|                                                    | Couple                                       | Sentimental relationship of two people          | 0.458  |
|                                                    | Friends                                      | Link that is established in a classroom         | 0.594  |
| Motivation                                          | Professor                                    | Profession that teaches and instructs           | 0.622  |
|                                                    | Coworker                                     | Employment relationship                         | 0.568  |
|                                                    | Age                                          | Biological time of a person                     | 0.496  |
|                                                    | Auditory                                     | Ear devices                                    | 0.434  |
|                                                    | Ventilation                                  | Device to refresh                              | 0.527  |
|                                                    | Bibliography                                 | Reference source                               | 0.425  |
|                                                    | Time                                         | Formative period                               | 0.408  |
|                                                    | No attendance                                | He does not attend class                       | 0.411  |
|                                                    | ICT                                          | Communication technology                        | 0.460  |

To analyse the goodness of chi-square adjustment with significance level higher than 5% indicates a good fit of the measurement model. Goodness of fit index (GFI), picks up the variability explained by the measurement model, its value oscillates between zero and one. It is considered that the adjustment of the measurement model is good for values higher than 0.9. Adjusted goodness of fit index (AGFI), GFI index adjusted by the degrees of freedom, it is considered that values higher than 0.9 show a good adjustment of the measurement model. RMSEA or mean square error of approximation, measures the absolute difference between the matrices observed and estimated [5] states that this measure is representative of the goodness of the adjustment that would be expected if the model were estimated with the population. Values between 0.05 and 0.08 are considered acceptable. The confirmatory analysis in Table 2, shows a model with GFI = 0.97 acceptable, KMO = 0.79, ECVI = 0.87 acceptable, NFI = 0.92, NNFI = 0.95. On the other hand, analysis shows in financial mathematics and probabilities that the surveyed students expressed knowing the objective along with the whole thematic axis specified for each semester, although they do not have knowledge. Hypothesis testing allows to verify that there is a direct relationship of interpersonal human relationships with competencies. Given that there is a significant effect between human relations and cognitive competence = 0.074 (≥ 0.05 recommended value), a value P = 0.08405 and Tucker-Lewis index = 0.95, the hypothesis is not rejected. The model financial mathematical learning is represented in Equation (1):

\[ F_{\text{Math}} = 1.8 \times \text{cognitive competence} + 2.93 \times \text{human relation} + 0.5 \times \text{Resources} \]  

(1)
4. Discussion
The didactic term comes from teaching methodology [6], is the pedagogical discipline of a practical and normative nature whose specific purpose is teaching technique [7], that is, the technique of directing and effectively guiding the students in their learning, is the study of methods and procedures, the tasks of teaching and learning in didactics are considered as the set of techniques through which the teaching is carried out, for this purpose it gathers and coordinates with practicality all the conclusions and results that come from the sciences of education, in order to make said teaching more effective. In general, according to Hu, school success has a multidimensional nature in which cognitive and emotional elements participate in this sense of students according to their disposition [8] and behaviour according to their acceptance of the academic environment.

Table 2. Confirmatory model.

| Latent variable | Measurement variable | Coef. Stand. \(\lambda_i\) | Comunality \(\lambda_i^2\) | \(\alpha\) of cronbach | Coef. compound reliability | Adjustment |
|-----------------|----------------------|---------------------------|--------------------------|------------------------|---------------------------|------------|
| Human relations | Family               | 0.296                     | 0.205                    |                        |                           |            |
|                 | Couple               | 0.138                     | 0.092                    |                        |                           |            |
|                 | Classmates           | 0.599                     | 0.657                    |                        |                           |            |
|                 | Coworkers            | 0.525                     | 0.741                    |                        |                           |            |
|                 | Professors           | 0.572                     | 0.426                    | 0.709                  | 0.909                     | \(X^2(2) = 2.850\) |
|                 | Age                  | 0.036                     | 0.008                    |                        |                           |            |

Supported by Salazar and Vergel, ontological conceptions allude to the nature of the reality that we seek to investigate. It is the object of study, the phenomenon that seeks to explain or interpret [9]. In teaching processes and learning processes, there cannot be a student without a teacher [10]. So learning is channelled through the innovative structure of information technologies, there will always be behind it, a virtual teacher who has produced it, so that other individuals can use it [11]. Hence, in this research report evidence the low-scale start of the use of information technology when tutors guide students to consult the databases with the aim of appropriating knowledge. In the contributions of authors in education and models, prevail the concepts of self-esteem and confidence, two of the weaknesses found in the students object of study [12], because in them it is uncommon to see that they take positions to express their dissatisfaction with the attitudes or behaviour of their peers [13], this situation leads them to answer in a superficial way to the questions about their experiences of coexistence and compromises their assertiveness because most of them find it difficult to clearly define their social expectations, according to Ibarguen and Martinez [6].

In the results of the test applied subcategories are prioritized, in which cognitive empathy is called to normal reach and the same with the affective empathy, despite what was found in the interviews and the observations is that they have assumed behaviours of distrust or indifference. Faced with this incongruity that is reflected between attitude and action, the empathic disposition is affected, an effort that students fail to achieve because they are more concerned with themselves than with others.

5. Conclusions
The conception of distance education is determined as an opportunity that people have access to higher education and therefore to a profession, because time had not allowed them to study before, and now commitments remain inaccessible given the condition socioeconomic and social that affects them. The teaching of financial mathematics can be considered within a framework of globalization as a social construction in which the academic community participates actively in the development and maintenance of society over any type of frontiers. Money, study, rates, interest, finance, mathematical, financial, company, decisions, investments, credits, banking, financial, capital, set, methods, capital, economic, evaluation, calculate, values, level, visit, subject were included in the conceptions of the
students of financial mathematics, contents contemplated in nuclear axes with scopes of knowledge of financial, economic, and business management, namely in economics, state, organizations, and in the social and human formation of young people, in which must have the capacity to problematize effectively. Financial mathematics is aimed at stimulating the development of cognitive skills and abilities, which in a later phase translates into analytical and critical skills.

References
[1] Landis J and Koch G 1977 Measurement of observer agreement for categorical data Biometrics 33 159
[2] Paz L, Vergel M and Rojas J 2018 Concepciones de educación a distancia y matemática financiera desde la comprensión onto-histórica de sus actores (Bogotá: ECOE ediciones)
[3] Vivant E 2013 Creatives in the city: Urban contradictions of the creative city City, Culture and Society 4 57
[4] Garcia J 2012 Análisis y claves del éxito escolar: Una reflexión compartida Edetania 42 200
[5] Alarcón J 2004 Estudio sobre los beneficios académicos e interpersonales de una técnica del aprendizaje colaborativo en alumnos de octavo grado en la clase de matemáticas Revista EMA 9 106
[6] Ibarguen E, Martinez J and Vergel M 2016 Modelos estimados de análisis de supervivencia para el tiempo de permanencia de los estudiantes de la Universidad Francisco de Paula Santander Respuestas 21 28
[7] Hosmer D W and Lemeshow S 2000 A goodness-of-fit test for the multiple logistic regression model Communications in Statistics A10 1043
[8] Hu L and Bentler PM 1999 Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives Structural Equation Modeling 6 55
[9] Salazar J and Vergel M 2018 Hermeneusis de la práctica pedagógica y formación de estudiantes matemáticamente competentes en Investigación y praxis en la enseñanza de las matemáticas (Bogotá: Universidad Simón Bolívar)
[10] Secolsky Ch 1987 On the direct measurement of face validity: A comment on nevo Journal of Educational Measurement 24 82
[11] Harf R 2013 La estrategia de enseñanza es también un contenido Revista Novedades Educativas 149 36
[12] Peláez M 2013 Dimensions of rules and their correspondence to rule-governed behavior European Journal of Behavior Analysis 14 259
[13] Yan J, Ye K, Wang H and Hua Z 2010 Ontology of collaborative manufacturing: Alignment of service-oriented framework with service-dominant logic Expert Systems with Applications 37 2222