Long Distance Education: Democratizing Higher Education Access in Brazil

Daniel Clark Orey, Milton Rosa
Universidade Federal de Ouro Preto

The authors led a group of diverse students, using long distance technologies to develop mathematical models in relation to their experience with the nationwide protests related to a sudden and steep climb in transportation costs during June 2013 in Brazil. Mathematical modeling became a teaching methodology that focused on the development of a critical and reflexive efficacy that engaged students in a contextualized teaching-learning process that allowed them to become involved in the construction of solutions of social significance. It is important to outline here the theories related to critical mathematical modeling, distance interaction, and transactional distance by using long-distance technologies. This approach coupled with long distance education allows for the democratization of higher education in Brazil.

Introduction

In recent years, Brazil has experienced an accelerated economic growth with accompanying social changes. The country is now the 7th largest economy in the world. It sponsored the 2014 World Cup and it is sponsoring the Olympics in Rio de Janeiro in 2016, and is suffering a tremendous amount of modernization in relation to infrastructure, including that of health and education. Nation-wide a process of upgrading teacher competencies and the training of new teachers on a massive scale is making a difference in school and community quality of life. The most expedient, economical, indeed reasonable method to do this is by integrating the use of long distance and multimedia technologies.

To increase access to a wider audience, we make use of Moodle as the platform and freeware; this has enabled the *Brazilian Open University* system to democratize and increase access to higher education. The study of new educational and methodological proposals

became relevant as it promoted social changes resulting from contemporary scientific and technological development. The need to update and upgrade professional development for teachers raises new institutional solutions, methods and resources in order to meet the demand for specialized teacher education programs such as in mathematics as imposed by social and technological developments.

Long Distance Education in Brazil offers teacher education programs for prospective teachers in regions that traditionally have had limited access to higher education and professional development opportunities. This was developed because face to face teacher education programs cannot meet the tremendous need or allow people the time required by traditional instruction to earn degrees. It is is performed by using a variety of technologies as well as special organizational and administrative arrangements between universities and municipalities. Several actions by the Brazilian Ministry of Education and Culture (MEC) were developed for teaching and learning in a long distance modality and forms part of a National plan representing the intention of the government to invest in distance education and a new digital era of informational and communicational technologies that support teaching practices and professional development.

The Long Distance Education program in Brazil aims at meeting the demands of the 21st century. This program is mediated by emerging technologies and methodologies in order to cover all educational levels and social classes. According to the Brazilian Law No. 5622 promulgated in December, 19th 2005, Long Distance Education is characterized as an educational modality in which didactical and pedagogical mediation is facilitated in the teaching and learning processes and occurs through the use of a variety of informational and communicational technologies. In this process, students and teachers develop educational activities in diverse and distinct locales and times.

This context allows federal universities in Brazil to offer *Seminars in Mathematical Modeling* in long distance mathematics undergraduate courses, which are offered entirely in an environment mediated by technology and the internet. The development of the activities in these courses is conducted through the use of the Moodle platform that possesses interactional tools among teachers, tutors, and students. In this regard, the *Centro de Educação Aberta e a Distância* (*CEAD*) at the *Universidade Federal de Ouro Preto* (*UFOP*) have come to integrate

instruction, technology, digital media, content and pedagogical methods in order to reach a diversity of students.

In just this university alone, there are over 4500 students enrolled in four undergraduate majors such as Mathematics, Geography, Pedagogy, and Public Administration, CEAD students represent 41% of UFOP students live in three states (Bahia, Minas Gerais, and São Paulo) who access courseware and instruction via 31 *polos* (long distance education centers). UFOP provides one of the largest distance education programs in Brazil.

The Role of Long Distance Education

In Brazil, push back in regards to long distance education is evident, especially in regards to its implementation in higher education. UAB was developed with the mission of providing access to higher education to a population of prospective learners who have not had access to higher education. Article 80 of Law No. 9394/1996, which is the Brazilian guidelines and basis for education, states that the government must encourage the development and diffusion of distance education programs at all educational levels.

Over the past few decades, and in many diverse locations in Brazil, distance education has grown quickly. Beginning initially with the use of mail-order courses, it transitioned to include radio and television. Once associated with mail and printed materials, it facilitated the dissemination and democratization of access and has now moved to the internet and MOOCS. It has become a key element in the democratization for many countries and now allows access to education and professional development opportunities once only given in face to face and to elite members of society. In Brazil it has allowed a portion of the population that traditionally has had difficulty in accessing public education to advance. In a distance education students and teachers are in different locations during all or most of the time in which they either learn or teach (Moore & Kearsley, 2005).

Although this type of education might in some ways hinder traditional teacher-student relationships, strangely enough it also allows students who had never had access to professors or teachers to gain contact. Distance technologies answer the need of a population who deserve initial or continuing education opportunities. Distance

education allows for educators and learners to break barriers related to time and space, and allows for interactivity and information dissemination. Many distance education environments are open systems that are composed of flexible mechanisms for participation and decentralization, with control rules discussed by the community and decisions taken by interdisciplinary groups (Moraes, 1997).

This approach allows interactions between teachers who prepare instructional materials and strategies, with tutors, who in the case of Brazil provide hands-on face to face assistance at polos. In Brazil, tutors are tasked to assist students in their activities and tasks, guiding them in their doubts, helping them learn to use search tools, libraries, and offer help in writing and basic math skills. These interactions are triggered by lessons on "platforms" that are virtual learning environments (VLE) and enables the use of technology and the teaching and learning of specific content. These features have enabled the development of large variety of educational methodologies that utilize web interaction channels and aim to provide needed support in the achievement of VLE curricular activities.

Theory of Distance Interaction

Interactional distance learning tools seek to eliminate the gap in respect to the understanding and communication established between teachers, tutors and learners because by either time or geographic distance (Moore & Kearsley, 2005). Distance education is considered an important feature or element of this form of education and is often supplanted by differentiating procedures, instructional and pedagogical tools that facilitate interactions. In this sense, distance education may need to be redefined as a different pedagogical concept for teaching and learning.

According to this theory, there is a real need for distance education students to exercise interactions in VLE that facilitate understanding and the comprehension of new content and activities. This interaction allows students the opportunity to make or answer questions and in most subjects also allows for the expression of opinions. This theory considers that the time and space distances found between teachers, students and tutors needs to be overcome with the inclusion of differentiating instruction and the use of technologies in the process of teaching and learning (Moore & Kearsley, 2005). According to this

context, new learning tools are adapted for use in classrooms such as mathematical modeling in mathematics courses.

Theory of Transactional Distance

Before the development of the concept of the Theory of Transactional Distance, definitions for distance education were related to the physical separation of teachers and students. Transactional distance differs from the physical or temporal distance as it refers to the psychological and communicative space that separates teachers from teaching students of transactions triggered in an educational system in distance modality (Moore, 1993), which occurs in planned and structured virtual learning environments.

In the educational process, the Theory of Transactional Distance requires the presence of students, teachers, tutors, and a channel of communication in order to resolve situations of teaching and learning that involve different transactional distances and require different techniques or even specialized forms of instruction (Martindale, 2002). It describes relationships and interactions that exist between teachers, students and tutors and were often established when these individuals were separated by time and space.

However, for this interaction to satisfactorily take place there is a need to discuss the extension of the length of a particular transactional education program, which depends on a set of three distinct qualitative variables: dialogue, program structure and the range of autonomous possibilities for students. It is also emphasized that these many variables are not always technological, as they relate to the interaction between teaching and learning itself (Moore, 1993).

This theory seeks to utilize information, technology, and the inherent communication found in structuring coursework, which prioritizes interactive educational processes centered on the learners themselves. In this educational process, transactional distance is a pedagogical phenomenon and not just a geographical issue. In general, it describes the interrelationship between three categories named dialogue, structure and learner autonomy as well as how these interactions influence the intensity and the quality of the transactional distance.

These theories utilize information technology and communication in structuring coursework, which prioritizes interactive and

collaborative educational process centered on learners. This approach investigates the influence that distance education has in the teaching and learning process in curriculum development, and in the organization and management of educational programs (Moore & Kearsley, 2005).

Critical and Reflexive Mathematical Modeling

In the last three decades, critical and reflexive mathematical modeling as a method for teaching and learning mathematics has been a central theme in mathematics education in Brazil. In teacher education programs this is a way to rebuild or restore part of fragmented knowledge students acquired during their previous mathematics learning experiences. Critical and Reflexive Mathematical Modeling has become one of the most important lines of research for processes of teaching and learning of mathematics in Brazil.

This work points out some reasons for teaching and learning of mathematics aimed at solving real world problems that makes use of critical mathematical modeling as a methodology that values and enables connections between mathematics and reality. However, this aspect is not commonly reflected in teaching practices of mathematics teachers. Much of the literature related to mathematical modeling and their critical perspectives contributes to the formation of both critical and reflexive teachers and presents us with opportunities for the meaningful learning of mathematical concepts by students in virtual environments (Rosa & Orey, 2012). As a methodology in a VLE in undergraduate courses for prospective mathematics teachers, it allows for the exploration of issues related to the context and interest of students and thus provides meaning for mathematical content under study.

By using this critical and reflexive mathematical modeling, perspective teachers encourage the examination of a variety of ways in which students develop and use certain mathematical procedures so that they learn to identify and propose solutions to problems faced in everyday life. This process is crucial to the development of an informed, active, and critical citizenship. One of the necessary pedagogical practices for transforming the nature of mathematical teaching is the deployment and implementation of this perspective

in long distance mathematics undergraduate courses (Rosa & Orey, 2012). This approach helps prospective teachers to examine, interpret and understand phenomena that affect their daily lives.

Interpreting and understanding these phenomena are due to the power provided by critical and reflexive mathematical modeling, which occurs through the critical analysis of the applications of mathematical concepts during the development of mathematical models in a VLE. Thus, the process of developing mathematical models is not a neutral activity because the solution for modeling a problem situation includes the understanding of how ideas and mathematical concepts are designed in the preparation, analysis, and resolution of these models. Thus, it is important that mathematical results obtained in this process are linked to the reality of the students themselves (Barbosa, 2006).

During the process of constructing a model, it is necessary to describe, analyze, and interpret phenomena present in reality in order to generate critical and reflective discussions about different processes for the resolution of the models, which are prepared by students. Thus, it is important to enable true reflections of reality, which become a transformative action that allows students to practice explanations, sharing their understandings, develop abilities to organize, manage, and find solutions to problems that present themselves (Rosa & Orey, 2007).

This both critical and reflexive discussion triggers a cycle of construction of mathematical knowledge from reality through the process of mathematical modeling. In this process, students develop skills that help them to process information and define essential strategies to perform actions that aim to the transformation of reality (Rosa & Orey, 2007). This kind of discussion provokes in students the ability to comprehend and debate about the implications of mathematical results, which flow from the resolution of problem and situations.

In this regard, critical and reflexive mathematical modeling is considered as an artistic, indeed poetic process because in the process of elaboration of a model, modelers need to possess mathematical knowledge as well as develop a certain a sense of intuition or creativity that enables this interpretation. In this direction, students need to work in a motivating VLE so that they are able to develop and exercise creativity, reflection, and criticality during the process of generation, analyzes, and production of knowledge.

According to this context, mathematical modeling is considered as a learning environment in which students are invited to inquire, investigate, and work with real problems as well as use mathematics as a language for understanding, simplifying, and solving these situations in an interdisciplinary fashion (Barbosa, 2006). In the context of critical and reflexive mathematical modeling process, students communicate by using hermeneutics (written, verbal, and non-verbal communication) that can be developed by using the VLE.

The Brazilian National Curriculum for Mathematics developed in 1998 states that students need to develop their own autonomous ability to solve problems, make decisions, work collaboratively, and communicate effectively. This approach is based on abilities, which help students to face challenges posed by society by turning them into flexible, adaptive, reflexive, critical, and creative citizens. This aspect emphasizes the role of mathematics in society by highlighting the necessity to analyze the role of critical thinking in relation to the nature of mathematical models as well as the function of modeling that solves everyday challenges.

So, when Brazil suddenly erupted in protest, it seemed the perfect opportunity to look at the question of transportation that people were concerned with. Having a number of diverse polos with a diversity of costs, populations and social contexts seemed a rich opportunity, not to be missed. This approach allowed the determination of the main goals for schools that relate to the development of creativity and criticality to help students apply different tools to solve problems faced in their daily lives as well as competencies, abilities, and skills to help them to live in society. This context also allowed for the development of a critical and reflexive mathematical modeling, which enabled students to develop mathematical models related to proposed transportation themes.

The Development of Critical and Reflexive Mathematical Modeling in VLE

Mathematics is often referred to as a language, but it seems that it has become a language that is taught without giving leaners the opportunity to communicate mathematically. It is not until learners

reach advanced mathematics that the few that survive this process, are afforded the opportunity to engage in communicating and creating new ideas using the beauty and power found in the language of mathematics. It is no wonder then, that most people detest mathematics. To them mathematics is stuck in endless and boring drills in the use of mechanical and mathematical grammar without being able to write or communicate in this synthetic but powerful language.

In Brazil, a strong culture of inquiry has developed in the mathematics education community by using critical and reflexive mathematical modeling in which students are encouraged to reflect upon, engage in, debate, and dialogue to resolve problems they find in their own contexts. For example, data gleaned from a course offered to mathematics majors in mathematical modeling that made use of an historic event, the nationwide 2013 demonstrations, to develop competency in mathematical modeling and how 110 students in 10 *polos* in two states (Minas Gerais and São Paulo) studied this raise in bus fares in their communities in Brazil and shared their findings with fellow students, faculty, and tutors.

In June 2013, early in the Seminar on Mathematical Modeling, the country erupted in mass demonstrations against the growing problem of corruption and over spending in relation to preparation for the 2014 World Cup tournament. Just in the small college town of Ouro Preto, 10,000 people marched from the university campus to the main square of the city. What sparked this national mass movement was a sudden spike in transportation fares in urban transportation systems. What may seem to those who do not use mass transit as something minor (20 cent rise) created a difficult problem for many who live in the large metropolises of São Paulo, Rio, Salvador, Brasilia, Fortaleza, and Belo Horizonte. Some long daily commutes became R$30 (about U$14) roundtrips five or six times a week and for many became untenable.

Normally a week or so is devoted to bringing consensus with students and generating a number of themes, and to make use of this particular historic circumstance the instructor consulted with the tutors and students and together they agreed that transportation would be the theme. Eight polos were participating in the seminar. The instructor asked the tutors at each polo to organize the students into smaller working groups of 4 or 5 students. Over a period of 5 weeks students were led through the steps, and groups were required to post evidence of their work on line.

Synchronous virtual classes were held. Critical mathematical modeling lessons were transmitted through videoconferences. Lessons were organized and activities and projects were posted in the Moodle platform. Discussion forums were also developed in order to prepare students for the modeling process. By the end of 16 weeks course 4 synchronous meetings were developed in which the elaboration of the mathematical models of each group of students was discussed. The course calendar that contained the description of the course, the terms of the proposed activities, and the dates and times of synchronous was published in the VLE. Approximately, every two weeks there were activities and questions to be worked on by the students and sent to the tutors and the professor through specific links in the Moodle platform.

Although geographically distant from the students during the development of the course, the professor and tutors used Moodle and youtube tools to be connected with them. Pedagogical and didactic strategies were used to promote professor and tutors interactions with the students in order to contribute to the process of teaching and learning the tools of mathematical modeling. The resources used were the discussion forums and videoconferences, which made possible the development of dialogues between all participants in the VLE. In addition to promoting interaction, the professor prepared teaching materials as well as posted information about the structure and policies of the activities available in the VLE.

It is important to highlight the design of the use of digital communication technologies in the development of this course such as videoconferences and VLE guided the selection of procedures and techniques:

Videoconferences

Videoconferences enabled the integration of students, tutors and the professor for socialization and clarification of questionings; which allowed for a collaborative environment for sharing experiences on the proposed themes and promoted students attendance in the polos to develop their modeling projects. The use of videoconference proved to be very effective because it has sufficient teaching resources for conducting synchronous classes. In this perspective, knowledge is

translated in a dialogical way so these technological tools can be used as instruments to help students to critically think about problems they face daily.

The Virtual Learning Environment (VLE)

VLE allowed for continuous updates of the course content; the development of discussion forums concerning teaching practices in the critical mathematical modeling process and the elaboration of questions about the pedagogical and technical aspects of this process. VLE also allowed for the integration of students, tutors, and the professor through the tools to deliver messages; the provision of summaries of contents the course; conduction of pedagogical monitoring such as sending messages to all participants and participation in the discussion forums; and technical support such students and tutors access reports in the VLE. According to this perspective, students' engagement with a sociocultural environment helps them to be involved in meaningful and complex activities. It is through social interaction among teachers and students from distinct cultural groups that learning is initiated and established.

The Importance of the Virtual Learning Environment (VLE)

In the mathematical modeling process, the social environment also influences cognition in ways that are related to cultural contexts. In this context, collaborative work through the VLE between teachers, tutors, and students makes learning more effective as it generates levels of mathematical thinking through the use of socially and culturally relevant activities Thus context allows the use of a *dialogical constructivism* because the source of knowledge is based on social interactions between students and environments in which cognition is the result of cultural artifacts in these interactions (Rosa & Orey, 2007).

For example, the results from the study conducted by Orey and Rosa (2014) showed that mathematical modeling became a teaching

methodology that focused on the development of a critical and reflexive efficacy that engaged students in a contextualized teaching and learning process, which allowed them to become involved in the construction of solutions to problems of social significance. This critical dimension of mathematical modeling is based on the comprehension and understanding of reality, in which students were able to learn, reflect, analyze, and take actions on their reality. Students explored examples and problems taken from their own reality, which helped them to study the symbolic, systematic, analytical, and critical contexts through the use of technological tools provided in a VLE.

According to this context, critical and reflexive mathematical modeling provides concrete opportunities for students to discuss the role of mathematics as well as the nature of their models as they study systems taken from reality through the use of technological tools in the VLE. It can be understood as a language to study, understand, and comprehend problems faced by community. For example, mathematical modeling is used to analyze, simplify, and solve daily phenomena in order to predict results or modify the characteristics of these phenomena.

The purpose of this modeling process becomes the ability to develop critical and reflexive skills that enable teachers and students to analyze and interpret data, to formulate and test hypotheses, and to develop and verify the effectiveness of mathematical models. In so doing, the reflections become a transforming action, seeking to reduce the degree of complexity of reality by choosing a system that can represent it (Rosa & Orey, 2007).

By developing strategies through technological tools provided by VLE encourage students to explain, understand, manage, analyze, and critically reflect on all parts of this system. This approach optimizes pedagogical conditions for teaching and learning so that students understand a particular phenomenon in order to act effectively and transform it according to the needs of the community. In order to lead students towards the understanding of the critical and reflexive dimension of mathematical modeling is to expose them to a wide variety of themes (Rosa & Orey, 2007). As part of this process, questionings in the VLE are used to explain or make predictions about the phenomena under study through the elaboration of models that represent these situations.

Final Considerations

The study of new methodological proposals becomes relevant because it originates with the ideas regarding social changes resulting from ongoing continuous contemporary scientific and technological developments. In order to enable teaching methods using structured learning materials and existing technological resources, it was developed the long distance learning, which refers to planned learning that normally occurs outside of school (Moore & Kearsley, 2005).

In the last three decades, critical mathematical modeling as a teaching and learning methodology has been one of the central themes in mathematics education in Brazil and has come to offer a way to rebuild or restore what has become for many, a fragmented and meaningless mathematical knowledge. This approach appears to encourage them to develop more informed and research-based opinions in their real life.

Long distance education contributes and can assist students to overcome difficulties regarding the adoption of critical and reflexive mathematical modeling courses because technological tools offered by the platforms such as Moodle are simple and funcional. Through the use of discussion forums and videoconferences, professors and tutors are able to critically analyze interactions enabled by these tools, which contributed to the reflexive development of the elaboration of mathematical models in the VLE.

References

Barbosa, J. C. (2006). Mathematical modelling in classrooms: a socio-critical and discursive perspective. *ZDM, 38*(3), 293–301.

Martindale, N. (2002). *The cycle of oppression and distance education*. Athabasca, Canada: Athabasca University.

Moore, M. G. (1993). *Theory of transactional distance*. In D. Keegan (Ed.), T*heoretical principles of distance education* (pp. 22–38). London: Routledge.

Moore, M., & Kearsley, G. (2005). *Distance education: a systems view*. Belmont, CA: Thomson Wadsworth.

Moraes, M. C. (1997). *O paradigma educacional emergente* [The emergent educational paradigm]. Campinas, SP: Papirus.

Orey, D. C., & Rosa, M. (2014). Much ado with nothing: how much Brazil has dramatically increased access to higher education using long distance education. In Luitel, C. C (Ed.), *Proceedings of the 5th ERT Symposium* (pp. 1–15). Dhulikhel, Nepal: Kathmandu University.

Rosa, M., & Orey, D. C. (2007). A dimensão crítica da modelagem matemática: ensinando para a eficiência sociocrítica [The sociocritical dimension of mathematical modeling]. *Revista Horizontes, 25*(2), 197–206.

Rosa, M., Reis, F. S., & Orey, D. C. (2012). A modelagem matemática crítica nos cursos de formação de professores de matemática [Critical mathematical modeling in the mathematics teacher education program]. *Acta Scientiae, 14*(2), 159–184.