Vol. 5, N°17, pp. 367– 374, Mars 2026

ISSN : 1987-1465
DOI : https://www.doi.org/10.62197/BOWI6424
Indexation : Copernicus, CrossRef, Mir@bel, Sudoc, ASCI, Zenodo
Email : RevueKurukanFuga2021@gmail.com
Site : https://revue-kurukanfuga.net

La Revue Africaine des Lettres, des Sciences Humaines et Sociales ***KURUKAN FUGA***

DIFFICULTIES IN LEARNING NUMERICAL SEQUENCES AND SERIES: THE CASE STUDY OF ENGINEERING STUDENTS AT ENETP, A TECHNICAL AND VOCATIONAL SCHOOL IN MALI"

Dr CAMARA Fafré -Normal School of Vocational and Technical Education; MALI)
Department of Studies and Research
Email fafrecamara@gmail.com
Dr Abou Sidibé -Institute of University Pedagogy, Bamako
Email sidibe83abou@gmail.com
Dr KONATE Siaka-University of Segou, MALI
Email gnatiosia@gmail.com

****

Abstract: This study investigates difficulties encountered by engineering students in learning numerical sequences and series at the Normal School of Vocational and Technical Education (ENETP) in Mali. Engineering students at ENETP have difficulties in learning sequences and series, which globally impacts their performance. This study aims to analyze the main difficulties associated with the introduction of the concepts of sequences and series in ENETP engineering classes. Using a quantitative-dominant design, data were collected through structured questionnaires administered to 309 first-year students and 7 mathematics teachers across civil, industrial, and mining engineering streams. Descriptive statistical analysis reveals that over two-thirds of students lacked prerequisite knowledge of numerical sequences, while major difficulties were reported in applying convergence tests, understanding limits, and selecting appropriate analytical methods. Teacher shortages, limited professional training, and weak alignment between secondary and tertiary curricula further compounded these challenges. The findings highlight the need for curriculum reinforcement, targeted teacher professional development, and improved pedagogical approaches to teaching sequences and series in engineering education in Mali.

Key words: engineering students, Mali, mathematics, numerical sequence, numerical series

****

Résumé : Cette étude étudie les difficultés rencontrées par les étudiants en ingénierie dans l'apprentissage des séquences et séries numériques à l'École normale d'enseignement professionnel et technique (ENETP) au Mali. Les étudiants en ingénierie à l'ENETP rencontrent des difficultés à apprendre les séquences et séries, ce qui impacte globalement leurs performances. Cette étude vise à analyser les principales difficultés liées à l'introduction des concepts de séquences et de séries dans les cours d'ingénierie à ENETP. En utilisant un plan d'enquête à domination quantitative, les données ont été collectées à travers des questionnaires structurés administrés auprès de 309 étudiants de première année et de 7 enseignants de mathématiques des filières du génie civil, industriel et minier. L'analyse statistique descriptive révèle que plus des deux tiers des étudiants manquaient de connaissances préalables sur les séquences numériques, tandis que des difficultés majeures ont été rapportées lors de

l'application des tests de convergence, de la compréhension des limites et du choix des méthodes analytiques appropriées. La pénurie d'enseignants, la formation professionnelle limitée et la faible adéquation entre les programmes secondaires et tertiaires ont aggravé ces défis. Les résultats soulignent la nécessité de renforcer le programme, de développer les enseignants professionnellement ciblés et d'améliorer les approches pédagogiques des séquences et séries d'enseignement dans l'enseignement de l'ingénierie au Mali
Mots-clés :Étudiants en ingénierie. Mali, mathématiques, séquence numérique, séries numériques

****

Introduction

Mathematics plays a central role in engineering education, as it underpins key analytical tools used in disciplines such as signals and systems, control theory, and applied analysis (Nelson & Hjalmarson, 2009). Among the foundational mathematical concepts taught at the tertiary level, numerical sequences and series occupy a critical position due to their applications in limits, convergence analysis, differential equations, and engineering modeling. However, numerous studies report persistent difficulties among engineering students in understanding mathematical concepts, often linked to misconceptions, weak prerequisite knowledge, and negative perceptions of mathematics (Firouzian et al., 2012; Ihejieto, 1995). Specifically, research has shown that students struggle with the conceptual relationship between sequences and series, the use of convergence tests, and the interpretation of limits (Akgun & Duru, 2007; Alcock & Simpson, 2005; Earls, 2017).

Despite the recognized importance of sequences and series in engineering, learning outcomes in this area remain unsatisfactory in many contexts. These difficulties are often exacerbated by gaps between secondary and tertiary curricula, limited teacher preparation, and instructional approaches that emphasize procedural knowledge at the expense of conceptual understanding. In the Malian context, these challenges are compounded by systemic constraints, including shortages of qualified mathematics teachers, insufficient instructional resources, overcrowded classrooms, and frequent disruptions to academic calendars. Consequently, engineering students entering higher education often lack the foundational skills necessary to engage meaningfully with advanced mathematical concepts such as numerical sequences and series.

The central problem addressed in this study is the persistent difficulty experienced by engineering students in Mali in learning numerical sequences and series, despite their prior exposure to mathematics in secondary education. These difficulties raise concerns about students' preparedness, the effectiveness of teaching practices, and the alignment of instructional content with learners' needs and professional applications. Moreover, there is a noticeable lack of empirical research in Mali examining students' specific learning challenges in this domain, particularly within technical and vocational engineering institutions.

The main objective of this study is to investigate the difficulties encountered by engineering students in learning numerical sequences and series at the Normal School of Vocational and Technical Education (ENETP) in Mali. Specifically, the study aims to: (i) examine students' prerequisite knowledge and skills related to sequences and series; (ii) analyze teachers' instructional practices in introducing these concepts; and (iii) identify students' major conceptual and procedural challenges in understanding numerical sequences and series.

To achieve these objectives, the study seeks to answer the following research questions: What prerequisite skills do engineering students possess that may facilitate or hinder the learning of numerical sequences and series? How do mathematics teachers at ENETP introduce and teach these concepts? What difficulties do students encounter in understanding and applying numerical sequences and series? Based on these questions, the study hypothesizes that insufficient prior knowledge, limited pedagogical strategies, and weak curriculum alignment significantly contribute to students' learning difficulties in this area.

The study is grounded in constructivist learning theory, which posits that learners actively construct new knowledge by integrating it with prior understanding (Gagnon & Collay, 2001). From this perspective, effective learning of numerical sequences and series depends on students' existing conceptual frameworks and on teaching approaches that promote active engagement, conceptual reasoning, and meaningful problem-solving. Constructivism, therefore, provides an appropriate theoretical lens for analyzing both students' learning processes and teachers' instructional practices in this study.

The remainder of this paper is organized as follows**:** the next section presents the methodology of the study, which describes the research design, sample, data collection instruments, and analysis procedures. The results and discussion section then presents and interprets the findings. Finally, the paper concludes with a summary of key findings and recommendations for improving the teaching and learning of numerical sequences and series in engineering education in Mali.

1. Methodology

This study aims to analyze difficulties in learning numerical sequences and series among engineering students at ENETP. A quantitatively dominant mixed methods research design is used to investigate difficulties in learning the mathematical concepts of sequences and series among engineering students in Mali.

1.1 Research Design

This study used a quantitatively dominant mixed research design to investigate difficulties associated with learning mathematical concepts of sequence and series among engineering students in Mali.

This choice of quantitative study design came up looking at the nature of the study's objectives. In quantitative research, a researcher relies on statistical data from a large-scale study. Quantitative methods involve collecting a large number of observations to describe and/or explain a phenomenon or behavior; it is a question of making a numerical observation of a situation and highlighting possible causal relationships between selected variables (Aldebert & Rouzies, 2014). These are research methods that use mathematical and statistical analysis tools, to describe, explain, and predict phenomena through historical data in the form of measurable variables. According to Cornelius et al (2006), the use of quantitative methods is essential for a field of study to gain its legitimacy.

1.2 Sample and sampling strategy

The study collected data at the Normal School of Vocational and Technical Education (ENETP), a public higher education institution in Mali responsible for training secondary school teachers. Although five institutions in Mali offer comparable programs, ENETP was selected based on convenience and accessibility constraints, including academic calendar inconsistencies and the researcher's absence from the country. The target population consisted of students enrolled in programs where numerical series are taught within the Analysis 2 module, specifically in Civil, Industrial, and Mining Engineering. Given ENETP's relatively small size, the study adopted a census approach, including all mathematics teachers (7 in total) and all first-year undergraduate students in the three engineering programs, estimated at fewer than 450 students. This population was considered representative of engineering students' learning of sequences and series in Malian higher education.

1.3 Data Collection

To collect data from students and teachers at ENETP, two questionnaires were used: one administered to IE, CE, and ME students after completing the Numerical Series course in semester 2, and another addressed to mathematics teachers involved in teaching or supervising the Analysis 2 module. Both questionnaires included closed-ended (71%) and open-ended (29%) questions, allowing for the collection of qualitative data through a rigorous and transparent research approach.

Pilot testing was conducted to identify ambiguities and improve clarity, with particular attention to avoiding negative formulations. The final questionnaires were administered in French, the language of instruction in Mali, and distributed in person during class sessions. Participation was anonymous, non-evaluative, and completion took approximately 20–30 minutes. A total of 309 students and 7 teachers figured out for the study.

1.4 *Data Analysis*

Data analysis started with the cleaning of the data to ensure the accuracy of data entry. The researcher chose to exclude all the incomplete questionnaires. The simple Excel tabulation was used for data entry and processing which was simple and convenient. The entry was carried out (data entry) in successive groups, teachers, and CE, IE, and ME classes.

2. Results and Discussion

Based on the research method and the data collected, the findings of the study indicate that, in general, there is a limited number of teachers to teach mathematics in the country, particularly at ENETP. Furthermore, most of the few available teachers lacked the proper qualifications and experience to teach mathematics at this level. Lack of proper related qualifications further informed the lack of proper professional positions (ranks) among most teachers.

Regarding teachers' experience in teaching at a senior high school, results indicate that most teachers lacked the related experience to teach mathematics at this school; only 14% of teachers (1 teacher) taught in senior high schools and in vocational schools from which all ENETP students came. This is a major drawback in the learning experiences of students.

Regarding students' experiences with numerical sequence, which is a prerequisite concept of numerical series, very few students studied numerical sequence in senior high school; many either studied a little or had no chance to study at all. These findings are in line with what was confirmed by Gonzalez-Martin and Correia De Sa (2015), who said that the series is closely related to other mathematical notions, such as limits, sequences, and convergence; it is natural that the difficulties specific to these notions are also present with the series

Another factor that affected the learning of numerical series is that a few students had a negative attitude towards learning numerical series; specifically, 14% of students (43 respondents) who found the concepts of numerical series in relation to their training were not necessary; a substantial number found it useful for their career.

There were some key aspects that teachers and students perceived to be important learning aspects. These include: having a good knowledge of numerical sequence (prior knowledge), having notes of combinatory analysis, knowing the different convergence criteria and their applications, and using concrete examples (biology, natural phenomena, professional experiences, which are essential in the learning of numerical series.

Students faced several learning difficulties, notably in applying and selecting appropriate convergence criteria (Cauchy, comparison, integral test, etc.). Many showed confusion in distinguishing these criteria and in using mathematical proof by induction. Additional challenges included understanding geometric sequences, computing limits at infinity, evaluating integrals, and applying properties of circular, logarithmic, and exponential functions. Students also struggled with determining Taylor expansions of order n using the Maclaurin formula, decomposing series into simple elements, and identifying different types of series (geometric, Riemann, positive-term). Finally, choosing the appropriate test to prove convergence or to determine the radius of convergence remained a major difficulty.

These findings are similar to other findings on the related concepts elsewhere. As Earls (2017) puts it, students have difficulties recognizing a sequence as a function and have difficulties understanding definitions when studying sequences. Various other studies indicate that many students do not clearly understand the concept of sequence and series Akgun & Duru (2007); Earls, 2017).

Conclusion

This study aimed to analyze the main difficulties associated with learning the introductory concept of sequence and series among the three target streams of civil industrial, and mining engineering students of the normal school of technical and vocational education in Mali. According to the findings, the difficulties were attributed to teachers' insufficient qualifications and limited experience in teaching sequences and series, the fact that students were encountering these concepts for the first time, and some students' negative attitudes toward numerical sequences and series.

Based on the findings, we conclude that one of the most important lessons of this study concerns the importance of the role of prerequisites in teaching/learning a concept. Since series is closely linked to other mathematical concepts such as limits, sequences, and convergence, it is natural that the specific difficulties of these notions are also present with the series (Gonzalez-Martin and Corrreia De Sa, 2015); the same is true of all other mathematical notions. It concludes that

some difficulties are teacher-related while others are student-related. Furthermore, some factors are system-oriented and are neither in the control of teachers themselves nor of students.

3. Recommendations

Based on these conclusions, several recommendations are proposed. The Department of Education should strengthen the teaching of numerical sequences by emphasizing their fundamental concepts and foundations. Teachers should also provide students with a wide range of application-based exercises to enhance understanding and skill development. Since many students have no prior exposure to numerical sequences and series at the senior high school level, these topics should be formally introduced into the senior high school curriculum. Furthermore, as the study revealed a lack of teacher experience in teaching sequences and series, the government should implement continuous professional training programs to support teachers from senior high school through higher education.

References

A. S. Gonzalez-Martin et C. Correia De Sa. (2015). « Utilisation de la visualisation dans le développement historique des séries avant le 17e siècle. » *Une analyse à travers les ostensifs*. (espace mathématique francophone), GT7 :653-665.

Akgun, L & Duru, A. (2007). "Misunderstandings and Difficulties in Learning Sequence and Series: A Case Study." *Journal of the Korea Society of Mathematical Education Series*, 11(1):75-85.

Alcock, L. & Simpson, A. (2005). "A convergence of sequences and series 2: Interactions between nonvisual reasoning and the learner's beliefs about their role." *Educational Studies in Mathematics*,58 (1), 77 – 100.

Aldebert, B. and Rouzies, A. (2014). Quelle place pour les méthodes mixtes dans la recherche francophone en management ? *Management International/International Management/Gestiòn Internacional*, 19(1) :1-18.

CIAM *2e S. Collection Inter Africaine de Mathématique*s. Mathématiques *2e S.* Edition : EDICEF, 2003.

Cornelius B., Landström H., Persson O. (2006). "Entrepreneurial studies: The dynamic research front of a developing social science." *Entrepreneurship Theory and Practice, 2006.*

Dictionnaire Français Génie civil. (2021). from https://www.linternaute.fr/dictionnaire/fr/definition/genie-civil/ .

Earls David. (2017). *Students' misconceptions of sequences and series in second calculus*. [Doctoral Dissertations,] [University of New Hampshire],156. Retrieved from https://scholars.unh.edu/dissertation/156.

Firouzian, S., Ismail, Z., Rahman, R.A. & Yusof, Y.M. (2012). "Mathematical Learning of Engineering Undergraduates." *Procedia - Social and Behavioral Sciences,* 56: 537 – 545.

Gagnon, G. W., & Collay, M. (2001). *Designing for Learning: Six Elements in Constructivist Classrooms.* Thousand Oaks, CA: Sage Publications Inc, .

González-Martín, A.S., Nardi, E., & Biza, I.(2011). "Conceptually driven and visually rich tasks in texts and teaching practice: the case of infinite series." [J] *International Journal of Mathematical Education in Science and Technology,* ,42 (5), 565 – 589.

Hanley, S. (1994). "Essay On Constructivism." Retrieved from

http://www.inform.umd.edu/UMS%2BState/UMDProjects/MCTP/Essays/Constructivism.txt

Ihejieto, D. (1995). Parallelism in performance and the multifactor perspective on the instructional process – a case study of poor achievement in mathematics in a single-sex school setting. *International Journal of Mathematical Education in Science and Technology. 26(4), 559-565.*

L. Rozoy, B. Ycart. (2014). « Série Numériques, Université Joseph Fourier de Grenoble. » *Cours de Maths* en ligne UJF Grénoble, 1-56.

Les dico des définitions. 2012, from http://lesdefinitions.fr/genie_industriel.

Lessani, A., Yunus, A.S., Bakar, K.A., Khameneh, A.Z. (2016). "Comparison of Learning Theories in Mathematics Teaching Methods." [J]*21st Century Academic Forum,* 2016,*9*(1).

M. Buljold and al. (2018). « Oser les défis des méthodes mixtes en sciences sociales et sciences de la santé », *Cahier Scientifique,* 2018 : 117.

Nelson, J. & Hjalmarson, M. (2009). "Students' Understanding of Sequence And Series as Applied in Electrical Engineering." *American Society for Engineering Education, 2009,1-11.*

Office québécois de la langue française. (1998). from http://www.granddictionnaire.com/.

P. Struillou. (2014). « Enseigner les mathématiques en école d'ingénieurs. » *La Gazette des Mathématiciens*, SMF-Gazette_139, 2014 :62-69.

Roh, K. (2008). “Students’ images and their understanding of definitions of the limit of a sequence.” *Educational Studies in Mathematics*, 2008:69 (3): 217 – 233.

Sierpińska, A. (1987). “Humanities students and epistemological obstacles related to limits.” *Educational Studies in Mathematics*, 1987,18 (4):371 – 397.

Skemp, R. R. (2006). “Relational understanding and instrumental understanding. Mathematics Teaching in the Middle School.” *Originally published in Mathematics Teaching*, 2006, 12(2):88–95.