

Transactions on Computer Systems and Networks

Samira Hosseini

Diego Hernan Peluffo

Julius Nganji

Arturo Arrona-Palacios *Editors*

Technology-Enabled Innovations in Education

Select Proceedings of CIIE 2020

 Springer

Transactions on Computer Systems and Networks

Series Editor

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Information Technology, Kolkata, West Bengal, India

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Julius Nganji · Arturo Arrona-Palacios
Editors

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Eugenio Garza Sada.*

Preface

Across disciplines, from engineering to medicine, from social sciences and humanities to architecture and design or even law and business, Education penetrates every aspect of our daily life. This marks continuous improvement of the teaching models as a major task for everyone involved in Education at all academic levels. The all-encompassing nature of Education reaches research and innovation, entrepreneurship, management, and public policy which, in turn, requires a strong alliance between stakeholders across the Educational ecosystem. As the world tackles international crises such as poverty, limited access to technological means, and global pandemics, Innovation in Education, today, finds essentiality more than ever before. The growing complexities of the world we live in are evidenced by the need for more novel approaches to delivering the Educational contents. The transition from in-person to online classrooms requires a new set of skills and an improved level of flexibility and adaptability. New Educational trends and emerging technologies address some of the main challenges we face globally, while pedagogy-informed applications of technology present a window to understanding how Education will be shaped as a result of the drastic changes the world is undertaking.

The 7th International Conference on Educational Innovation (CIIE 2020) presents an excellent forum for introducing Educational practices and technologies complemented by various innovative approaches that enhance the Educational outcomes. In line with the Sustainable Development Goal 4 (Quality Education) of the United Nations in the Agenda 2030, CIIE 2020 has attempted to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.” The CIIE 2020 book of proceedings offers a diverse dissemination of innovations, knowledge, and lessons learned to familiarize readership with new pedagogical-oriented, technology-driven Educational strategies along with their applications to emphasize their impact on a large spectrum of stakeholders including students, teachers and

professors, administrators, policy makers, entrepreneurs, governments, international organizations, and NGOs.

Monterrey, Mexico
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Chapter 1

Natural Language Processing for Video Essays and Podcasts in Engineering



Patricia Caratozzolo, Alvaro Alvarez-Delgado, and Samira Hosseini

1.1 Introduction

The Organization for Economic Cooperation and Development (OECD), in its document “Future of Education and Skills 2030” (Howells 2030), and the World Economic Forum (WEF), in its report “Towards a Reskilling Revolution” (World Economic Forum Boston Consulting Group 2018), emphasize the need for new cognitive tools to develop and assess the transversal skills that Generation Z students must have. The reports highlight the following skills as fundamental: analytical thinking, innovation, creativity, originality, critical thinking, reasoning, problem-solving, and ideation. Today, with unpredictable global risks, such as the COVID-19 crisis, the educational models of Higher Education Institutions (HEI) must be flexible, adapting and implementing the necessary tools within viable models of quality education to avert the obsolescence of future engineers’ skills.

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Current HEI students are considered Generation Z (born after January 1, 1995) and have different communication skills and storytelling habits. In terms of their written communication outside of academia, Generation Z students prefer to communicate with short, quick text messages on social media platforms. For oral communications, they prefer to record short videos without much discussion and with improvised content. (Smith and Cawthon 2017; Cilliers 2017). These “narrative practices” of young people in their daily lives harm their academic and professional roles, weakening the strength of their scientific arguments, making it difficult to acquire technical vocabulary, and interfering with their critical inference and deduction skills (Caratozzolo et al. 2020). This problem triggered the present study, which framed the research question: How to effectively assess and improve Generation Z students’ critical and creative thinking, overcoming their difficulties expressing orally and in writing their opinions, arguments, and logical deductions?

The answer to this question may lie in the possibility of using natural language processing (NLP) techniques to perform modular analyses of their written presentations (executive reports, questionnaires, and case analyses) and oral presentations (speech and transcription in video essays and podcasts) and subsequently using the data for agile, timely feedback sessions. This project does not intend to create an automated essay scoring (AES) or a platform for automatically grading student essays written by students. Instead, we intend the project to support HEI instructors with better review and feedback sessions to students, providing personalized reports of their oral and written communication skills, language fluency, vocabulary level, structural complexity of arguments, and organized speech content.

The study’s objective was to leverage the functionalities and advantages of NLP to complement the evaluation of soft skills of engineering students (critical thinking and creativity), which is usually done manually by the instructor of each subject (Gunawansyah et al. 2020).

This study is a continuation of previous work, “Creativity in Criticality: Tools for Generation Z Students in STEM,” presented in April 2021 at the IEEE EDUCON Conference (Caratozzolo et al. 2021).

1.2 Theoretical Framework

Jerome Bruner points out two modalities of cognitive functioning. Each offers distinct ways of constructing reality and ordering experience (Bruner 2009). The *logical-scientific modality* (*critical thinking*) tries to fulfill the ideal of a formal mathematical system of description and explanation; and the *artistic-narrative modality* (*creative thinking*) deals with students’ ability to develop new technological products by converting imagined concepts into a dependable reality (Spuzic et al. 2016).

While the strategies for evaluating critical thinking are well known and used in engineering, the same is not the case with evaluating creativity since the options are limited to the well-known TTCT-style creativity tests (Caratozzolo et al. 2019). When choosing methods for assessing creativity, it was essential to understand the

qualities that students need to express it, that is, to unravel their cognitive process (Walia 2019). To build a flexible NLP model in this project, we considered the following characteristics of creative thinking:

Fluency, understood as the number of relevant ideas.

Originality, the amount of statistically uncommon, unusual, and unique ideas.

Elaboration, combining and adapting ideas of others, giving them “another twist,” showing a conviction to be creative.

Abstractness of titles (also known as abstract articulation or verbal intelligence), the ability to reason. It involves synthesis and organization and distinguishing the essence of information and recognizing what is essential.

Additionally, specific *serious storytelling* tools were used in the present study to improve the ability to analyze and combine existing ideas, texts, and images through new disruptive and alternative solutions. Serious storytelling enables opinions and perspectives to be developed contextually in scientific and technical applications, using narratives for a purpose beyond entertainment (Caratozzolo et al. 2020). The essential components of the storytelling approach considered to develop critical thinking and creativity were as follows:

Perspective: the subjective point of view that involves story characteristics that evoke cognition and emotion.

Narrative: the actual content of the story that includes mimesis and diegesis.

Interactivity: the essential interaction between the speaker and the audience that features engagement and decision.

Medium: the message that includes features such as content and forms.

Storytelling was an ideal cognitive tool to include in our competency-based learning approach in engineering because it involves active and collaborative learning and originates from students’ knowledge and previous experiences (Caratozzolo et al. 2019a).

1.3 Methodology

1.3.1 Research Design

A total of 323 undergraduate Generation Z engineering students voluntarily participated in our study. One hundred seventy-three of them underwent metacognitive instruction (experimental group), while 150 students did not receive the intervention (control group). A total of fifteen groups were involved over ten semesters, from January 2016 to November 2020. The project design was experimental, using the four-group Solomon type methodology: (1) experimental group with Pre-Test and treatment (EG-PreT-T); (2) experimental group without Pre-Test, only treatment (EG-T); (3) control group with Pre-Test (CG-PreT), and (4) control group without Pre-Test (CG) (Dawson 2019).

In this study, tests were designed to identify the following biases in the communication skills of Generation Z students: Inability to make intrinsically motivated, cognitive efforts; comfortable only reading predigested texts; lack of concentration when writing; and almost all written expression in texting language. The simultaneous combination of these characteristics presented an additional challenge to design an NLP approach to critical thinking—knowing that thinking is done in language—because students create their own language in their academic works and shortcut it by copying and pasting documents, relying on automatic word processors to correct spelling, and using Web sources of dubious academic quality for their reports.

1.3.2 Instrumentation (Pre-Tests and Post-Tests)

Different types of instruments were considered for the study. Some validating tests for data collection and research were questionnaires, interviews, surveys, observation lists, VALUE Rubrics, and other tools to handle parametric data statistically.

Pre-Tests: Vocabulary tests, designed to establish the approximate lexicon level of each student, were compared to the Corpus of Contemporary American English, COCA, that contains 60,000 ranked words (Davies 2010); creativity scale self-reports and lateral thinking-ability checklists.

Post-Test: Fluency and originality tests, and rubrics based on the Valid Assessment of Learning in Undergraduate Education Rubric (VALUE Rubric) of the Association of American Colleges and Universities (AAC&U) (Rhodes 2010).

1.3.3 Experimental Settings (Treatment)

One of the best strategic didactic interventions incorporating the activities based on the cognitive understanding level of the students was training in the shifting mode of thinking experiences (Caratozzolo et al. 2019b). Our study considered the stiffness of the shifting mode among thinking modalities per the magnitude of two cognitive biases (Lu et al. 2017). *Premature closure* is the cognitive bias causing the student not to consider reasonable alternatives after an initial diagnosis of a problem. *Cognitive fixation* is the cognitive bias that causes the student to evaluate the functionality of an object only in the way it is traditionally used. Three types of activities were developed with students: dialogue seminars, supervised questioning sessions, and video essays and podcast recordings.

Dialogue Seminars. The dialogue seminar consisted of a meeting between a small group of students and a mentor during which students read their essays and the whole group shared their experiences. The inclusion of online sessions represented

an additional advantage because it facilitated recording the sessions and the subsequent transcription of the participants' interventions. The texts obtained from transcribing the sessions were analyzed with the Python NLP algorithms. (We obtained the students' prior consent and ensured personal data protection to preserve the participants' anonymity).

Supervised Questioning Sessions. The supervised questioning method stimulated the recall of knowledge acquired in previous sessions, sharpened understanding of concepts, and taught students to self-construct critical thinking skills. The method had the additional advantage of promoting peer interaction in a psychologically safe environment for discussion and argumentation (Duran-Novoa et al. 2019).

Table 1.1 shows an example of the application of the supervised questioning method.

Video Essays and Podcast Recordings (including transcriptions). The video essay is the audiovisual equivalent of the written essay, in which the "message" uses visual elements (and not just words) to enhance the point the interlocutor is making. Because Generation Z engineering students have trouble writing texts of more than several pages coherently, we considered the video essay an attractive tool due to its two main characteristics (Hernández-de-Menéndez et al. 2019): (a) its length, since most video essays do not last more than a few minutes, which allows the script to be relatively short in length, (b) the video essay is free-form; its format and rhetorical strategies can differ enormously from one video essay to another. From the point of view of the teaching-learning process in engineering, video essays show the audience things that could not be easily described in a traditional essay. Additionally, because the script was written following a serious storytelling technique, the visuals significantly enhanced the story and the plot.

The technological tools chosen for the present study were video essays and second-generation podcasts (podcasts with video), created from screencasts, with scripts prepared by the students on topics selected from the official syllabus of each course. They were recorded at the radio station facilities or with portable recording equipment (Myers and Visosevic 2017). The scripts were carefully prepared to offer a certain proportion of words belonging to the higher rank of the Corpus of Contemporary American English (COCA) (Davies 2010). The script also had a structure that facilitated shifting modes so that the student reached a higher cognitive stage to reflect on the nature of the subjects with a higher level of abstraction.

The following subsection includes some of the functionalities and experiences modeled in NLTK for different subjects in the sustainability development department. The experiment performed by the students was the analysis of the responses in the argumentative tests based on technical IEEE articles and a specialized dictionary on the subjects' syllabus topics, selected from updated IEEE databases (*Electrification* magazine and *Power and Energy* magazine) (Agüero and Khodaei 2018).

Table 1.1 Example of interference analysis (with NTLK/inference module) to determine the cognition level of students during Post-Tests

Dimensions and taxonomies	Question type (all in the high cognitive level)	Sample questions
Nonhierarchical questions	Brainstorm	If you could design a <i>transactive energy</i> research strategy, based on the IEEE's suggestions, what characteristics would it have?
	Divergent	Mexico was not ready in 2018 for the modernization of the Power Network. Why?
	Focal	Does the relationship between costs in the corresponding figure seem reasonable to you? Justify your answer
Questions based on cognitive dimension	Analyzing	Given the participation of <i>investor-owned utilities (IOUs)</i> , what would be the most favorable agreement among the parties to achieve the objectives of the <i>renewable portfolio</i> ?
	Evaluating	Based on the surveys in the IEEE text, what do you think was the biggest obstacle to the evolution of <i>utilities business models</i> ? Could it be extrapolated to Mexico?
	Creating	Given the challenge of incorporating emerging and advanced technologies to modernize the network, how would you mitigate the associated risks?
Questions based on knowledge dimension	Factual	According to the IEEE article, in 2018, some states in the USA were highly committed to modernizing the network. In what way and under what conditions could equivalent participation be considered in Mexico?
	Conceptual	There are different business models for the alternative utility. What similarities and differences do you find between them?
	Procedural	Considering the structure of the <i>distribution system operator (DSO)</i> shown in the corresponding figure Y, what are the strengths and weaknesses of a system with these attributions?
	Metacognitive	Considering the level of satisfaction you have when delivering this work, what do you think could help you in the future to produce a better deliverable?

1.3.4 Use of NLTK with Python

Natural language processing is a practical approach to understand the effectiveness of learning processes in engineering programs. Additionally, NLP provides solutions in a variety of fields and social and cultural contexts of competency-based learning.