

Mastering Professional English Communication: A Guide to Education 4.0 Tools and Techniques for ESL Teachers

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Abstract

In today's fast-moving world, where everything is changing and becoming one big village, the ability to communicate effectively in English is a must for any professional working in various industries. Education 4.0 has come with new technologies and teaching methods that are meant to improve Professional English Communication (PEC) among students who have joined the university recently. With context provided by the TPACK framework and Education 4.0; this study focuses on how PEC competencies can be enhanced by using them. It looks into how language teachers in tertiary education institutions of India can exploit Education 4.0 tools to teach PEC. To understand how teaching approaches can fit into dynamic student environments, it explores the practices that are currently being used as well as discovering alternative ones that can help meet learners' needs better. Participants were identified purposively and eighty nine individuals were involved in a quasi-experimental design study. For data collection purposes, a pre-test questionnaire was first distributed followed by intervention through Skill Share Sessions using the methodologies of Education 4.0 which involved intervening subsequently after some time of one month. After four weeks, a post-test questionnaire was administered, with data analysed using paired sample t-tests in SPSS. Results indicate significant enhancements in students' PEC skills, crucial for the evolving workforce. Participants benefitted substantially from Education 4.0 tools and strategies, though limitations were noted, paving the way for future research directions.

Keywords: Content Knowledge, Education 4.0, Pedagogical Knowledge, Professional English Communication, Technological Knowledge

1. Introduction

Technology integration has revolutionized the traditional pedagogy thereby being an essential driver in transforming education. There has been a clear trend over the years, in which educators and researchers have taken notice of technology as an agent for disruption, pushing many to now commit to what has become widely known as Education 4.0. This new paradigm encompasses a wider perspective on the incorporation of digital tools together with the new approaches to support learners in the 21st century. Inspired by Industry 4.0, Education 4.0 is shifting from a traditional classroom setup with students as receivers of knowledge to a more learner-centric one where creativity and critical thinking, collaboration competition-thinking-out-of-box-problem-solving etc skills are the requirements now being demanded out of Education 4.0. In response, it acknowledges the challenges of readying people for an ever-changing world in which technology and globalization are on overdrive.

Among the main facets of Education 4.0 is personalized learning paths and adaptive learning systems targeting each student's personal strengths, interests, and modes of study. This approach uses Artificial Intelligence (AI) support, and data-driven analytics to offer customizable content, assessments & feedback how it processes work (Miranda et al. 2021). Education 4.0 goes beyond traditional texts, by incorporating different technologies into learning. There's Virtual Reality (VR) and Augmented Reality (AR) for interactive learning with AI chatbots to provide real-time support, and Internet of Things (IoT) enabled devices that allow the smallest part to communicate easily on a web-scaled connected platform. Education 4.0 is more about lifelong learning and continuous professional development in an ever-changing world. All of these lead to self-directed learning, accessing Online resources and Upskilling/Reskilling for opportunities. This approach encourages collaboration between learners as well with educators from different parts of the world building deep intercultural learning and solidarity transformers. But accomplishing that goal would require universal language such as English. Several mobile applications are available for learning English communication. These applications use technology to gain an interactive and personalizing experience of learning a language. Mobile applications like Busuu, ELSA, Duolingo, Rosetta Stone Hello Talk, Memrise, Babel and Idict among many others have worked on Education 4.0 channels to improve English Communication (Álvarez Valencia, 2016).

As English has become the global lingua franca it connects people from all over the world with different cultural backgrounds. The importance of English proficiency is not only important to convey basic messages, even in professional life it has expanded the significance. In the increasingly globalized world economy and in this era of businesses going cross-national, possessing professional working proficiency in the English language has become one of the most essential skills that an individual belonging to the modern age must possess. Competence in Professional English creates numerous job opportunities in different fields from business and finance to technology, health care, and academia (Bhatia & Bremner, 2012). Employability is increased and enabled people to tackle the high competitive global job market. Being proficient in English has its advantages which result in covering all spheres like career growth, access to knowledge, networking opportunities, adaptability & versatility around cultural changes (Dhivya, Hariharasudan & Nawaz 2023). Adopting Professional English Communication opens up a myriad of avenues for people to seize success in the increasingly combative and unrestrained International job market.

This research article is an attempt to explore the imminent relationship between Education 4.0 and Professional English Communication (PEC). Based on the explorations, it proposes a possible approach to integrate Technical-, Content- and Pedagogical knowledge to potentially facilitate professional-context language skill development within an Education 4.0 framework. This study followed a quasi-experimental research design with the aid of paired sample t-test statistics in analyzing the findings. Furthermore, the research validates its findings by including Higher Education language educators in the Southern regions of Tamil Nadu, India.

2. Review of Literature

2.1 Education 4.0

Analyzing the process of education and the trends that govern it with the help of Information Technologies, Education 4.0 marks a new phase in the area of education and other related fields as influenced by technological growth and traditions of education. It is based on the prior generations of education's foundation and accepts the profferings of the fourth industrial revolution. With web connection enhancement and online learning materials being available conveniently, online learning systems made their way into the educational front to provide convenience and timely learning instead of formal education. This created new possibilities for learners to get educational content at any time and in any place, thereby eradicating time and space barriers (Wallner and Wagner, 2016). The trend of Massive Open Online Courses (MOOCs) emerged which allowed persons to obtain knowledge and skills from highly accredited universities and masters in the given field all across the world (Mohamad Alakrash & Abdul Razak, 2020). In addition, the increased and wide use of mobile gadgets including smart mobile phones and tablets enhanced the usage of technology education. The mobile learning applications and technologies in the form of educational games make use of a more dynamic style of 'coming at' the students. Another type of technology that fulfilled its potential during this period was AI and VR technologies that brought students inside the classrooms and reshaped the possibilities of experimenting in education (Haderer & Ciolacu, 2022). Further, Education 4.0 goes beyond the concept of integrating technology. It also aligns with the paradigm that has shifted in educationalists' approach that aims at cultivating skills needed in the 21st century such as computer literacy, study skills, knowledge, thinking skills, inventive thinking, verbal skills, and collaborative skills. Educators are encouraged to adopt learner-centred approaches, where students actively participate in the co-creation of knowledge and develop skills that are relevant to the demands of the digital age (Hariharasudan & Kot, 2018).

2.2 Professional English Communication (PEC)

PEC refers to the ability to effectively convey ideas, information, and opinions in the English language within a professional context (Bhatia & Bremner, 2012). It involves the use of appropriate vocabulary, grammar, tone, and style to communicate, confidently, and professionally with colleagues, clients, and stakeholders in various professional settings. Proficient PEC skills are essential in today's globalized and interconnected world (Gajek et al., 2022). They play a crucial role in career advancement, networking, collaboration, and building strong professional relationships. Effective and efficient communication technology and practice in the workplace promotes productivity, teamwork, and understanding of diversity among the employees, therefore academics should prepare their students for their future workplaces by providing them with efficient communication skills (Thavabalan et al., 2021). Effective possession of proficient PEC allows the client to securely introduce them to their professional mastery, gain credit, and succeed in the chosen occupation (Anaelka, 2018). Online and mobile learning tools allow orientation in private study and informal language use (Carri ó-Pastor & Skorczynska, 2015). Besides, acknowledging the changes that have occurred in education as a field, teachers have to gain new technology in order to teach PEC. Thus, the incorporation of IoT supports the educational processes used by educators showcasing the improvement of their instructional approaches and the subsequent preparedness of students to communicate in the professional environment, which will meet the requirements of the current employees' workplaces (Gavrilova & Kira Trostina, 2014). Therefore the following hypothesis is arrived at

H1: Utilizing Education 4.0 results in improved proficiency in teaching PEC skills compared to the pre-implementation phase.

2.3 Content Knowledge

Listening skills are of paramount importance in PEC as they facilitate comprehension, understanding, and effective communication in diverse workplace settings. According to a previous study active listening is vital for building positive relationships, among co-workers (Symonenko, 2020). Effective listening allows professionals to grasp instructions, understand client needs, negotiate effectively, and respond appropriately, thereby contributing to successful communication and overall organizational success. Effective interpersonal communication is essential for building professional relationships. Active listening, empathy and choice of words are underlined as the

means for developing rapport and comprehension of the needs of the coworkers, clients and other stakeholders (Torres C & Zeidler, 2002).

Essentially, speaking skills are of paramount importance in the use of effective PEC since speaking is the primary mediator (Al-Eiadeh et al., 2016). These skills enable a person to be able to express him or herself very well, present information and ideas effectively, participate effectively in meetings, negotiate convincingly, and build and maintain healthy working relationships. In Professional Communication, general tidings and public speaking are components. Stress and organization, cohesion and coherence, and presentation skills are some of the aspects emphasized drawing from the literature (Muttaqin & Chuang, 2022). Effective skills in organizing the content of a presentation or speech, the use of appropriate graphics, eye contact, and keeping the attention of the audience can improve PEC in public speaking situations.

Literacy skills are crucial for PEC since it helps the individuals to read and understand different documents, get informed on topics within the profession, and improve the knowledge within certain fields (Krepel et al., 2021). Thus, in working contexts, people regularly encounter technical or specialized writings related to their fields of practice. Literacy is imperative in order for professional to be able to comprehend as well as navigate these files, which include manuals, reports, journal articles, and papers. As a result of works, it is quite clear that certain degree of technical knowledge and language proficiency in the field of specialization is crucial for proper understanding of the information contained in these texts. Such skills are indispensable in today's professional landscape. (Bojovic, 2010).

Effective professional writing requires clarity and coherence. Clarity involves expressing ideas concisely and understandably, avoiding ambiguity and confusion. Coherence entails organizing thoughts logically and maintaining a cohesive flow of information throughout the writing (Tangpermpoon, 2008). Developing these skills enables professionals to convey their messages accurately and engage readers effectively. Proficiency in grammar, vocabulary, and sentence structure is crucial for professional writing. Proper grammar usage ensures clear communication and helps convey ideas accurately (Demydovych & Holik, 2020). A strong vocabulary allows professionals to use precise and appropriate language, while varied sentence structures add depth and sophistication to their writing. Continuous learning and practice in these areas enhance professionals' writing skills (Sajid & Siddiqui, 2015). Adopting an appropriate tone and style is essential in professional writing. Professionals need to consider their audience, purpose, and context when determining the tone and style of their writing. The tone should be professional, respectful, and consistent with the intended message. Writing style should align with the expectations and conventions of the specific professional field or industry (Mayer, 2014). Developing the ability to adjust tone and style using professional content enhances the effectiveness of professional writing. To effectively teach PEC using Education 4.0, teachers must prioritize building a solid foundation of content knowledge. This entails not only mastering the intricacies of the English language but also understanding the specific communication skills required in professional contexts. Therefore, the subsequent hypothesis is formulated.

H2: The utilization of Education 4.0 leads to an enhanced proficiency in Content Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

2.4 Pedagogical Knowledge

Teachers can teach PEC using Education 4.0 if they have proper knowledge of teaching which in this case is referred to as pedagogical knowledge. This acknowledges the contribution of the various factors towards making adjustments on the various instructional strategies that educators and learners use, to the learning process and the way student's language is fostered. Knowledge for teaching starts with the learner need, learner's achievement, and their aspirations (Moreno & Vermeulen, 2015). The educators and learners should reflect on the teaching and learning language abilities, as well as the specific PEC goals in the learning process and learning styles (Srivani & Hariharasudan, 2023). It helps them to address students' heterogeneity and to design the educational processes with an awareness of how learners differ from one another (Demydovych & Holik, 2020). Due to this, knowledge related to teaching practice proves vital in the formulation of a curriculum that executes the goals and objectives of the PEC. It is suggested that real-life activities should be integrated into the programs, and contexts as well as materials from industries should be included (Hariharasudan et al., 2021). They have to know language skills and subskills related to business communication, define comprehensible learning outcomes and select proper assessment tools (Walsh & R íquez, 2020).

Education 4.0 lays a strong focus on the use of technology in teaching and learning activities (Gajek et al., 2022). This branch of knowledge allows the learners to integrate the use of technologies, web resources and management of learning tools for effective teaching of PEC. Blended learning approaches, combining face-to-face and online components, facilitate self-paced learning, collaborative activities, and personalized feedback (Torres & Zeidler, 2002). Task-based and project-based learning approaches provide students with opportunities to practice PEC in authentic contexts (Thavabalan et al., 2021). Pedagogical knowledge guides educators in designing tasks and projects that simulate real-world professional situations, allowing students to develop language skills while addressing practical challenges. Such approaches foster critical thinking, collaboration, and problem-solving skills (Saha, 2023). PEC often involves interactions with individuals from diverse cultural backgrounds. Pedagogical knowledge supports the development of intercultural competence, helping students understand cultural differences, adapt their communication styles, and demonstrate respect and sensitivity in professional contexts. Hence teachers need to adopt new teaching and communicative strategies utilizing Education 4.0, such as active listening, negotiation, and persuasive techniques, to enhance students' ability to navigate cross-cultural communication challenges (Allam, 2016). Therefore, the following hypothesis is formulated.

H3: The utilization of Education 4.0 leads to an enhanced proficiency in Pedagogical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

2.5 Technological Knowledge

Technological knowledge is crucial for studying PEC using Education 4.0, as it involves leveraging digital tools, online platforms, and technological resources to enhance language learning and communication (Dhivya, Hariharasudan, Ragmoun, et al., 2023). Digital literacy is fundamental for students to navigate and utilize digital tools effectively. It encompasses the ability to use technology for communication, information retrieval, collaboration, and content creation. Soon, students will need to be proficient in tasks such as operating computers, accessing online sources, and using productivity software like presentation virtual programs, and communication platforms (Farias-Gaytan et al., 2022). Reading has evolved to fit online platforms, e-books, and digital articles. Individuals must be able to read digitally and thoroughly search through online resources to extract the necessary content for their profession (Srivani et al., 2022). These skills include scanning and skimming web content, evaluating online sources, and adapting reading strategies for various digital texts (Eshet-Alkalai, 2004). Many organizations rely on online communication tools to run efficiently, using project portfolio management software. Students should be skilled in managing emails, online discussion boards (ODF), video chat platforms like Zoom, and messaging apps such as Artefact. Technological literacy is essential for effective communication and collaboration with peers, as well as interaction with instructors in a virtual environment (Tinmaz et al., 2022). Students learn by creating digital content as part of Education 4.0 (Srivani, Hariharasudan, Nawaz et al., 2022). With content-creation tools, students gain the digital literacy needed to make well-presented presentations, videos, and infographics, enhancing their ability to communicate multimedia-based ideas (Kaeophanuek et al., 2018).

In Education 4.0, applications such as Busuu and ELSA help students develop their communication skills directly through their phones. These apps let students study at their own pace and on their preferred devices (Oliveira & Saraiva, 2023). Often incorporating gamification and interactivity, these courses are more engaging than traditional ones (Li & Yu, 2022). They provide interactive workouts, vocabulary games, grammar concepts, and speaking practice. Additionally, Busuu's social features allow users to connect with native speakers and receive feedback on their language skills. ELSA (English Language Speech Assistant) is designed to enhance English speaking and pronunciation skills. Based on speech recognition technology and AI, this app offers individual feedback on the accuracy of your speaking (Kholis, 2021). ELSA offers a variety of exercises and practice activities to help users improve their spoken English, focusing on reducing accents and increasing fluency. Numerous Education 4.0 applications, such as Duolingo, Rosetta Stone, Babbel, Memrise, Busuu, HelloTalk, Tandem, Lingodeer, FluentU, and Pimsleur, are designed for universal access and are readily available. Their efficacy hinges upon their ability to align closely with the specific requirements of individual learners. Consequently, language educators must possess a thorough understanding of these applications. Their proficiency in this regard is instrumental in guiding learners towards selecting and utilizing the most appropriate application to optimize their learning experience. Therefore, the following hypothesis is derived.

H4: The utilization of Education 4.0 leads to an enhanced proficiency in Technical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

The following concept map (Figure 1) is a visual tool used to represent the relationships between different concepts. It is typically created to illustrate the connections and hierarchy among various ideas using the Technological Pedagogical Content Knowledge (TPACK) framework within Education 4.0 for teaching PEC.

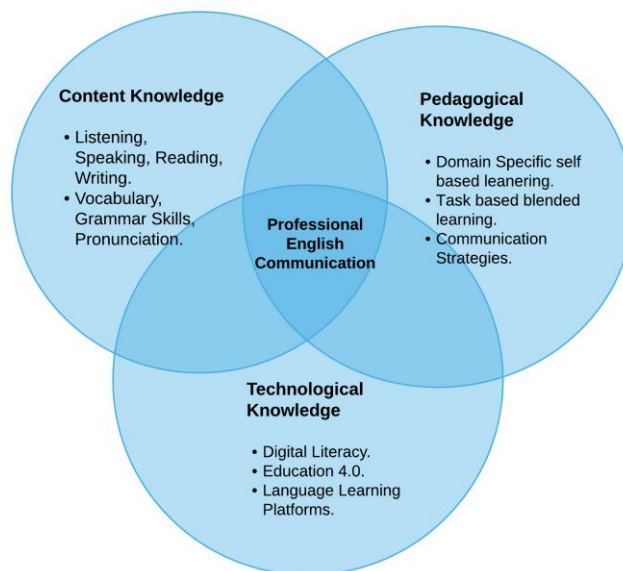


Figure 1. Concept map using Education 4.0 framework

2.6 Statement of the Problem

In today's globalized world, the importance of PEC skills is widely recognized. Yet, learners still struggle with how to learn and build these foundational skills throughout their educational journeys. The single largest barrier is the challenges educators face in efficiently integrating PEC into their curricula using traditional educational strategies. On the other hand, Education 4.0 is appealing as it entails technological intervention and learner-centered approaches but little has been done in terms of its practical integration into enriching PEC. Accordingly, there is an urgent need for focused research due to limited knowledge on the issues and opportunities surrounding the use of Education 4.0 in instructing PEC. It then goes on to address this gap with the aid of Technological Pedagogical Content Knowledge (TPACK). This review focuses on how learners can effectively learn professional English Communication (PEC) skills by incorporating Education 4.0 into teaching strategies for language educators.

This study will explore how educationists employ tools related to Education 4.0 like new learning models and mastery of subject matter content in higher education to improve PEC skills development. This work will probe innovative teaching methods with a view of identifying appropriate techniques for developing PEC skills. The aim of this inquiry is to expose how teachers could exploit the potential behind Education 4.0 in order to develop dynamic teaching environments that facilitate effective enhancement of PEC skills among students.

2.7 Objectives of the Study

- To investigate the Content Knowledge for teaching PEC using Education 4.0
- To identify the Pedagogical Knowledge for teaching PEC using Education 4.0
- To explore the Technological Knowledge for teaching PEC using Education 4.0

3. Methodology

The research that used a quantitative approach was done by using the quasi-experimental research design. The participants were recruited from Higher Education language educators pool through purposive sampling techniques. This is shown in Figure 2 below. Specifically, this study focuses on Higher Education language educators. The first step involved undertaking a pre-test to measure the respondents' pedagogical knowledge and content as well as technical aspects in teaching PEC skills. To do this, a questionnaire survey with fifty statements based on a Likert scale was adopted for that purpose. This was followed by Skill Share Sessions during which teachers worked on integrating Education 4.0 through TPACK to improve teaching PEC skills. The duration of the intervention was extended over four weeks. After the intervention, a post-test was administered using a separate questionnaire that utilized a 5-point Likert scale, aiming to evaluate any enhancements or progress made. Pre-test and post-test assessments will gauge the effectiveness of teachers' instructional strategies, ensuring alignment with learning objectives and fostering a culture of continuous improvement. The collected data from both questionnaires were analyzed using IBM SPSS statistical tool version 21.

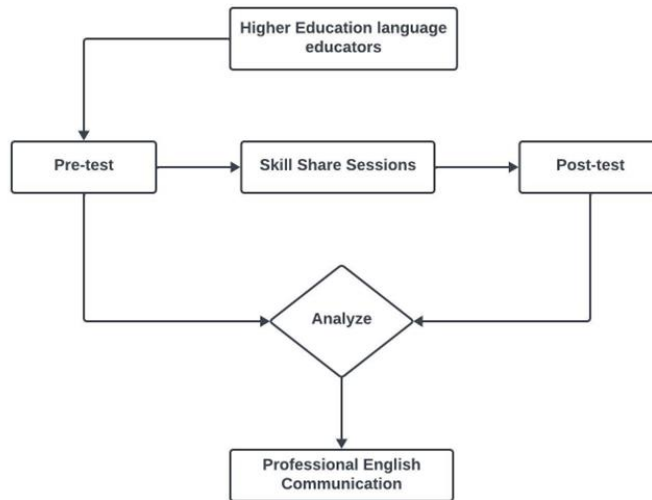


Figure 2. Visual representation of the research plan

3.1 Participants

Before conducting the survey, explicit consent was obtained from participants to carry out the research. Subsequently, invitations were extended to potential participants, highlighting the importance of their involvement and emphasizing the principles of voluntary participation, confidentiality, and anonymity. It was assured that the collected data would only be presented in summarized form. The study employed a quasi-experimental design specifically targeting teaching PEC skills using Education 4.0. Therefore, Higher Education language educators in the southern region of Tamil Nadu were purposefully selected as participants. A total of 89 Higher Education language educators participated in the study. All participants were requested to complete a pre-test questionnaire, which included demographic information.

3.2 Instruments

The pre-test involved the distribution of a questionnaire via Google Forms, utilizing a 5-point Likert scale 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree to collect participants' opinions solely on their skills. All questionnaire questions were made mandatory to ensure participants' full completion before submitting the forms and also included a section to gather participants' demographic information. A total of 20 questions were included in the questionnaire, evenly distributed across various variables such as Content Knowledge, Pedagogical Knowledge, Technological Knowledge and PEC. To ensure the questionnaire's validity, field experts reviewed and validated it. The questionnaire's reliability was assessed using the IBM SPSS tool. Table 1 depicts the case summary of participation and Table 2 resulting in a Cronbach's Alpha value of 0.824, indicating a good level of internal consistency.

Table 1. Case Summary Processing

| | | N | % |
|-------|-----------------------|----|-------|
| Cases | Valid | 89 | 100.0 |
| | Excluded ^a | 0 | .0 |
| | Total | 89 | 100.0 |

Source: Values are given based on the collected data

Table 2. Reliability

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .824 | 20 |

Source: Values are given based on the collected data

For the post-test, a similar Likert scale-based questionnaire was created, mirroring the structure of the pre-test questionnaire. The post-test questionnaire also consisted of 20 questions, equally distributed among the variables. Demographic details of the participants can be found in Table 3.

Table 3. Demographic details

| S.no | Demographic details | Range |
|------|---------------------|-------------------------------------|
| 1 | Gender | Male = 40; Female = 49 |
| 2 | Age | Aged < 20 = 45; Age > 20 = 44 |
| 3 | Region | Urban = 45; Rural = 44 |
| 4 | Education | Post Graduate = 44 ; Doctorate = 45 |

Source: Values are given based on the collected data

3.3 Procedure

Detailed instructions regarding the study were provided to the participants, along with the establishment of a dedicated WhatsApp group to address any inquiries or concerns they might have had. Using Google Forms, a pre-test was administered to 89 Higher Education language educators, ensuring that all fields in the questionnaire were mandatory to guarantee complete form submissions. The questionnaire, which aimed to evaluate participants' existing knowledge was distributed via the WhatsApp group. The data collected from the pre-test questionnaire were securely stored for further analysis.

The intervention plan, Skill Share Session is crafted as a three-day workshop to assess and enhance teachers' teaching skills in PEC using Education 4.0. Through comprehensive training sessions, hands-on workshops, collaborative lesson planning, and ongoing support, educators will develop proficiency in integrating Education 4.0 within the TPACK framework specifically tailored for teaching PEC. Figure 3 shows the detailed plan of the training sessions following the TPACK framework for teaching PEC skills

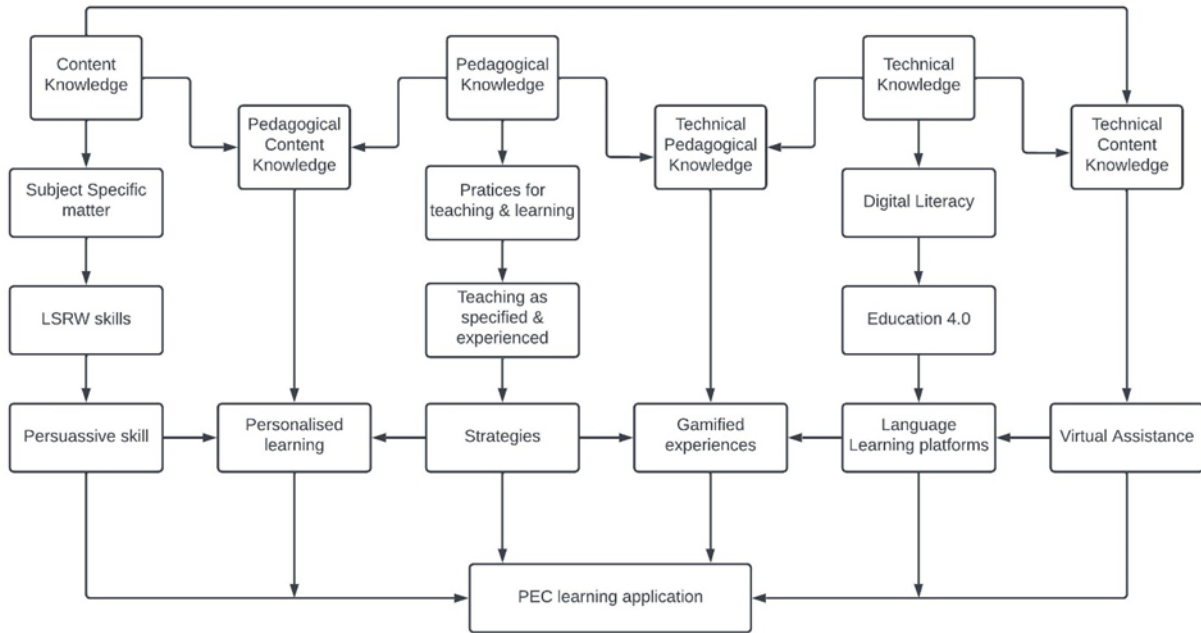


Figure 3. Detailed intervention of the study

On the first day of the workshop, participants dove into the core concepts of TPACK, with a strong emphasis on improving PEC skills. Interactive sessions helped them understand how technology, teaching methods, and subject knowledge come together to create effective learning experiences. They explored strategies for integrating digital tools into their English instruction, learning how these tools can support various learning styles, boost digital literacy, and engage students in meaningful communication.

The second day of the workshop provided training to the participants with hands-on experience in managing Education 4.0 platforms such as ELSA, Busuu, Duolingo, Chatbots, Hello Talk, Duolingo, Memrise, Rosetta stone for teaching PEC. The participants learned how to exploit various digital learning platforms, develop interactive learning materials and make online communications possible among students. This made them more efficient when teaching Professional English with engaging multimedia resources, interactive exercises as well as real-life simulations for better language proficiency like LSRW skills.

By the third day, this had shifted to a discussion on collaborative lesson planning and ongoing support for learners in technology enhanced teaching. In this case, they used co-designed lessons; shared resources and gave feedback from one person to another so that they could maximize on technology use in teaching professional English. Furthermore, there were conversations about guiding students through digital learning environments with personalized assistance while ensuring that all learners access resources equally thus giving them equal chances of success in developing their communication abilities in English.

Offline mode is what the workshop is run in, spanning a period of three days. Each day has six hours of training. For three hours of their time in the morning, the participants are engaged in theoretical sessions introducing TPACK framework and ideas on how to blend technology to maximize learning outcomes. The subsequent part comprises of discussion periods that will enable individuals engage into group work by using Education 4.0, share views and solve any problem raised during the workshops as learning experiences continue. Participants are expected to begin implementing the TPACK framework within four weeks after completion of the three-day training through lessons for normal school timetable slots. After this implementation period, post-test was given to respondents through questionnaires aimed at assessing efficacy of intervention introduced. Data from the post-test was collected and both pre- and post-test data were analyzed using Paired Sample t-test through SPSS version 21 so as to determine if there were significant changes in teaching practices and students'

learning outcomes among participants after attending these workshops.

4. Results

These findings have been obtained through the use of SPSS and a paired sample t-test is conducted whose results are presented in the tables below. Further, a paired sample t-test was used to measure improvement over the intervention period. The paired sample t-test is a statistical method that enables one to compare means between two groups and thus evaluate assumptions made on the population when testing hypothesis, hence assessing how much had been achieved towards population impact by intervention. The SPSS computed mean averages were exhaustively evaluated for all variables on pre-tests as shown in Table 4. The pre-test average mean values were: Professional English Communication (PEC) - 4.0719, Content Knowledge (CK) - 4.1438, Pedagogical Knowledge (PK) - 4.2337, and Technological Knowledge (TK) - 4.2337. In addition, average mean values of post test data have also been computed with SPSS software package for this study too; therefore, the post-test average mean values were: Professional English Communication (APEC) - 4.6112, Content Knowledge (ACK) – 4.5326, Pedagogical Knowledge (APK) – 4.6697, and Technological Knowledge (ATK) – 4.7101 as given below. Additionally, Table 4 provides the standard deviation (SD) values for all variables, which were calculated based on a sample size of 89 participants.

Table 4. Paired Samples Statistics

| | | Mean | N | Std. Deviation | Std. Error Mean |
|--------|------|--------|----|----------------|-----------------|
| Pair 1 | PEC | 4.0719 | 89 | .36587 | .03878 |
| | APEC | 4.6112 | 89 | .39122 | .04147 |
| Pair 2 | CK | 4.1438 | 89 | .31187 | .03306 |
| | ACK | 4.5326 | 89 | .35025 | .03713 |
| Pair 3 | PK | 4.2337 | 89 | .26669 | .02827 |
| | APK | 4.6697 | 89 | .27486 | .02913 |
| Pair 4 | TK | 4.2337 | 89 | .29269 | .03103 |
| | ATK | 4.7101 | 89 | .33305 | .03530 |

Source: Values are given based on the collected data

Table 5 presents the paired sample correlation, employing Pearson's correlation coefficient to assess the magnitude and direction of linear associations between variable pairs. In establishing meaningful associations between variables, correlation values play a crucial role. The range of Pearson's correlation coefficient, denoted as "r," extends from -1 to 1, indicating perfect positive correlations. The determination of the significance of a correlation is based on the analysis of the p-value. A p-value lower than 0.05 indicates a statistically significant correlation, whereas a p-value greater than 0.05 suggests a lack of statistical significance. It is important to consider both the Pearson coefficient and the p-value together. Table 5 presents the correlation values and corresponding p-values for each variable, pairing the pre-test and post-test data for the respective variables, employing a paired sample t-test and showing the positive correlations and statistically significant values for all the variables.

Table 5. Paired Samples Correlations

| | | N | Correlation | Sig. |
|--------|------------|----|-------------|------|
| Pair 1 | PEC & APEC | 89 | .880 | .000 |
| Pair 2 | CK & ACK | 89 | .760 | .000 |
| Pair 3 | PK & APK | 89 | .805 | .000 |
| Pair 4 | TK & ATK | 89 | .712 | .000 |

Source: Values are given based on the collected data

Table 6 displays the outcomes of the paired sample test, presenting the mean difference and standard deviation (SD) scores for all variables. In this analysis, the average means of the variables obtained from both the test data are compared. To assess the observed improvement during the intervention period, a paired sample t-test was performed. The differences between the average means of the pre-test data and the post-test data were determined by comparing them for the following variable pairs: PEC - APEC, CK - ACK, PK - APK, and TK - ATK. To evaluate the statistical significance of the findings, a two-tailed significance test was performed with a 95% confidence interval, resulting in p-values of 0.000, indicating significance.

Table 6. Paired Samples Test

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|-------|-----------|--------------------|----------------|------------|---|---------|---------|----|-----------------|
| | | Mean | Std. Deviation | Std. Error | 95% Confidence Interval of the Difference | | | | |
| | | | | | Mean | Lower | | | |
| Pair1 | PEC - APE | -.53933 | .18685 | .01981 | -.57869 | -.49997 | -27.230 | 88 | .000 |
| Pair2 | CK - ACK | -.38876 | .23230 | .02462 | -.43770 | -.33983 | -15.788 | 88 | .000 |
| Pair3 | PK - APK | -.43596 | .16939 | .01796 | -.47164 | -.40027 | -24.280 | 88 | .000 |
| Pair4 | TK - ATK | -.47640 | .24028 | .02547 | -.52702 | -.42579 | -18.705 | 88 | .000 |

Source: Values are given based on the collected data

Figure 4 illustrates the progress achieved during the intervention period, specifically focusing on the improvement among all the variables. The bar diagram demonstrates enhancement compared to the pre and post-test.

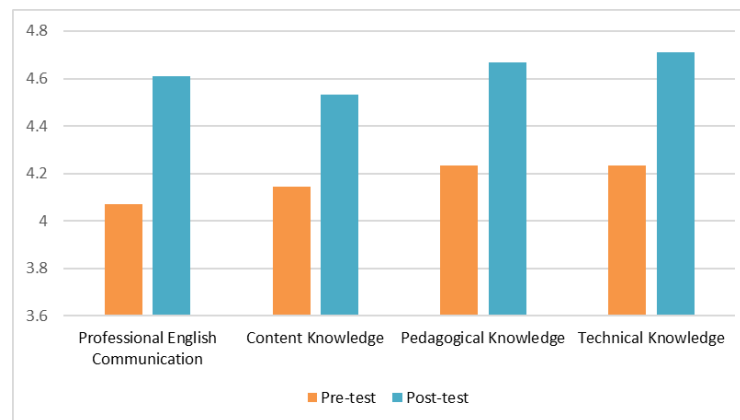


Figure 4. Mean difference

Source: Illustrated by the researchers

4.1 Hypothesis Testing

The tabulations presented in Tables 4-6 were employed to conduct hypothesis testing and corroborate the research findings. The analysis employed the paired sample t-test, a statistical technique that allowed for the comparison of means across groups. The aim was to investigate a hypothesis and determine whether a specific process significantly affects the participants.

H1: Utilizing Education 4.0 results in improved proficiency in teaching PEC skills compared to the pre-implementation phase.

Upon reviewing the statistics presented in Table 4, it was noted that the average means of the pre-test values for PEC (mean = 4.0719, Standard Deviation = 0.36587) were comparatively lower than the average means of the post-test values (mean = 4.6112, Standard Deviation = 0.39122). The significance value is supported by the correlation coefficient values for PEC ($r = 0.880$), as shown in Table 5, which is slightly below 0.9 and depicts a positive correlation. Table 6 shows that the paired difference between the test values produced an extremely significant result, with a p-value of 0.00, indicating mean differences between pre and post-test values. Furthermore, Figure 4 provides evidence of utilizing Education 4.0 results in an improved proficiency in teaching PEC skills compared to the pre-implementation phase. Hence, the research hypothesis H1 was confirmed.

H2: The utilization of Education 4.0 leads to an enhanced proficiency in Content Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

After analyzing the statistics in Table 4, it was noted that the average means of the pre-test values for Content Knowledge (mean = 4.1438, Standard Deviation = 0.31187) were comparatively lower than the average means of the post-test values (mean = 4.5326, Standard Deviation = 0.35025). The significance value is further supported by the correlation coefficient values for Content Knowledge ($r = 0.760$) presented in Table 5, which is slightly below 0.9 and depicts a positive correlation. Table 6 shows that paired differences between the test values resulted in a highly significant outcome with a p-value of 0.00, indicating mean differences between pre and post-test values. Additionally, Figure 4 shows that the utilization of Education 4.0 leads to an enhanced proficiency in Content Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. Therefore, the research hypothesis H2 was affirmed.

H3: The utilization of Education 4.0 leads to an enhanced proficiency in Pedagogical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

Upon examining the statistics in Table 4, it can be observed that the average means of the pre-test values for Pedagogical Knowledge (mean = 4.2337, Standard Deviation = 0.26669) were comparatively lower than the average means of the post-test values (mean = 4.6697, Standard Deviation = 0.27486). The significance value is supported by the correlation coefficient values for Pedagogical Knowledge ($r = 0.805$) as presented in Table 5, which is slightly below 0.9 and depicts a positive correlation. Table 6 shows that the paired difference between the test values yielded a highly significant result with a p-value of 0.00, indicating mean differences between pre and post-test values. Furthermore, Figure 4 shows the utilization of Education 4.0 leads to an enhanced proficiency in Pedagogical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. Therefore, the research hypothesis H3 was accepted.

H4: The utilization of Education 4.0 leads to an enhanced proficiency in Technical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation.

After analyzing the statistics in Table 4, it was observed that the average means of the pre-test values for Technological Knowledge (mean = 4.2337, Standard Deviation = 0.29269) were lower than the average means of the post-test values (mean = 4.7101, Standard Deviation = 0.33305). The significance value is further supported by the correlation coefficient values for Technological Knowledge ($r = 0.712$) presented in Table 5, which is slightly below 0.9 and depicts a positive correlation. Table 6 shows that paired differences between both test values resulted in a highly significant outcome with a p-value of 0.00, indicating mean differences between pre and post-test values. Additionally, Figure 4 shows that the utilization of Education 4.0 leads to an enhanced proficiency in Technical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. Therefore, the research hypothesis H4 was confirmed.

5. Discussion

Education 4.0 plays a significant role in the enhancement of communication skills, with the integration of effective learning methods and teaching techniques leading to improved abilities among students and the creation of sustainable learning environments. The present research examines the impact of Education 4.0 on teaching PEC Skills. Table 7 shows the study's findings aim to address the hypothesis by providing real-time performance-based evidence.

Table 7. Comparative analysis of existing research with the outcome of the study

| S.no | Research Question | Existing Research | | The outcome of the present study |
|------|--|---|---|--|
| | | Findings | References | |
| H1 | Utilizing Education 4.0 results in improved proficiency in teaching PEC skills compared to the pre-implementation phase. | Traditional teaching methods were used to enhance communication skills. | (Eady, Michelle J. and Lockyer, 2013; Matsumoto-Royo & Ram fez-Montoya, 2021; Pastore et al., 2019; Richards, 2013) | Education 4.0 supports personalized learning which induces motivation and enhances the communication skills among the learners while fostering a sustainable environment. |
| H2 | The utilization of Education 4.0 leads to an enhanced proficiency in Content Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. | Language textbooks and their instructional methods were used for broadening the content knowledge. | (Gavrilova & Kira Trostina, 2014; Symonenko, 2020; Torres & Zeidler, 2002) | Education 4.0 enables immersive learning experiences, independently explores language content resources, and actively participates in authentic contexts. |
| H3 | The utilization of Education 4.0 leads to an enhanced proficiency in Pedagogical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. | Engaging students in authentic and contextualized pedagogical activities such as collaborative learning. | (Dhivya, Hariharasudan, Rigmoun, et al., 2023; Kholis, 2021; Saha, 2023; Villalobos-Zúñiga & Cherubini, 2020) | Integration of AI gives access to a wide range of resources and materials and supports knowledge retention, contributing to the observed improvement in Pedagogical Knowledge. |
| H4 | The utilization of Education 4.0 leads to an enhanced proficiency in Technical Knowledge for teaching PEC skills compared to the proficiency levels before its implementation. | Emphasis on formal education, lectures, textbooks and hands-on training were used to enhance the language skills. | (Eady, Michelle J. and Lockyer, 2013; Pastore et al., 2019; Saidani Neffati et al., 2021) | Meets the diverse needs and learning styles of students and induces problem-solving abilities, and digital literacy. Adaptability and creativity were instilled. |

The findings emphasize the critical role of teaching through Education 4.0 in fostering PEC. Education 4.0, characterized by the integration of digital technologies such as AI, VR, and interactive platforms, not only enhances engagement and motivation among learners but also facilitates personalized learning pathways tailored specifically for developing PEC skills (Eady, Michelle J. and Lockyer, 2013), (Demydovych & Holik, 2020; Godfroid et al., 2013). Most times, conventional instruction is unable to cater for the intricate language needs essential for effective professional communication; thus, this may lead to less productive learning experiences (Molina-azorin et al., 2021). Nevertheless, the present study highlights how teachers can leverage Education 4.0 in order to offer immersive and self-guided learning opportunities that can take care of specific PEC requirements, thus having a positive impact on students' achievements.

Education 4.0 is the integration of digital technologies in the learning environment and it comes with a wide range of resources and tools that can enhance knowledge acquisition among teachers and students (Gavrilova & Kira Trostina, 2014). The present study is in line with this very investigation which goes to enrich teaching strategies for language instructors while teaching PECs. These include multimedia content, interactive platforms, mobile applications, and online resources through which teachers are exposed to a large volume of data (Torres & Zeidler, 2002). Conversely, often traditional instructional methods rely on language textbooks as their major source of knowledge. The findings from this study corroborate previous research that showed how important Education 4.0 is in promoting content knowledge acquisition among language educators (Sophonhiranrak, 2021). By being interactive Education 4.0 allows learners to interact with multimedia elements such as simulations and virtual environments thereby providing them immersive learning opportunities. These

interactive components facilitate students' understanding retention usefulness regarding PECs (Matsumoto-Royo & Ramírez-Montoya, 2021).

The findings of the current study are consistent with previous studies that supported the efficacy of Education 4.0 in enhancing pedagogical knowledge for teaching PEC (Troussas et al., 2020). Additionally, Education 4.0, which is a mix of digital technologies into the learning setting brings many opportunities to teach English language through authentic and contextualized pedagogical activities (Dhivya, Hariharasudan, Ragmoun et al., 2023). Furthermore, collaborative teaching especially when using AI promotes active interaction among teachers globally accentuating the need to instill critical thinking and problem solving skills within learners (Winans, 2020). However, using technology such as Symonenko (2020) suggests working together as groups sharing ideas, discussing and providing feedback helps educators gain deeper understanding of pedagogy concepts with technology and this is also confirmed by the present study linking people through Education 4.0 applications for teaching PEC. Moreover, Educational version Four point zero offers unlimited access to numerous resources and materials that enhance teachers' pedagogical knowledge acquisition for the purpose of teaching PEC. The online repositories interactive modules and multimedia content provide varied resources that can be used in language instruction by instructors (Goldin et al., 2022). These resources can expose students to various pedagogical approaches, teaching strategies, and effective communication techniques.

The findings of our study support the previous research on Education 4.0 effectiveness in enhancing technological knowledge acquisition for teaching PEC as was observed by Fleaca & Stanciu (2019) and Allam (2016). The contemporary investigation proves that digital technologies integration into Education 4.0 results in personalized learning and teaching opportunities. By employing tools like AR applications, VR simulations, and adaptive learning platforms, instructors can design teaching approaches to accommodate the diverse needs and learning styles of their students. The earlier study also showed that teachers who have access to multimedia resources including simulations, virtual labs and interactive exercises can provide a deeper understanding of technical concepts (Eshet-Alkalai, 2004). It is accompanied by this current research's observation that Education 4.0 allows accessibility as well as flexibility when it comes to technological information sources. For instance, Farias-Gaytan et al (2022) said that teachers can find various online materials such as videos or tutorials at a specific time convenient for them so that they are capable of reviewing their interpretations concerning technical ideas clearly.

Thus, the present research has revealed that integrating Education 4.0 into teaching PEC requires the fusion of Content Knowledge, Pedagogical Knowledge, and Technological Knowledge producing better outcomes for both teachers and learners. What makes this study unique is its method of addressing pedagogy in language among educators using TPACK framework to build PEC skills through Education 4.0. This study offers a contemporary and innovative approach to teaching PEC and enhancing language proficiency among students by employing Education 4.0 principles along with technology-based tools and applications. Additionally, the study examines how digital literacy among language educators, interaction with native speakers and various language skills integration promote overall language development. These factors are considered important as they make this research original bringing useful knowledge on effective teaching strategies aimed at improving PEC in the context of today's generation which is digital literate thereby making it unique in its own way. Moreover, it was found out from the study that participants can be distracted when they use internet because there is so much information available therein.

6. Conclusion

To conclude, the study about improved teaching of PEC skills through Education 4.0 under the TPACK model had significant findings. By integrating Education 4.0 devices and materials within the TPACK framework demonstrated its ability to enhance language proficiency, boost learner confidence, encourage collaboration, provide access to real resources, give room for flexibility and develop technology literacy. The findings revealed that TPACK framework is crucial in ensuring the effective integration of technology in language instruction. This provided a systematic method for teachers to fuse their own content knowledge, pedagogic learning and computer awareness leading to a well-rounded and smooth inclusion of Education 4.0 tools. As a result this integration not only enabled learners to have personalized self-paced learning but also allowed educators' autonomy in selecting the language resources necessary for enhancing their students' performance on PEC skills at any given time while utilizing new teaching approaches as they are ready for them one step at a time.

To sum up, the survey's results strongly suggest that PEC skills can be improved by Education 4.0 through the TPACK framework. This research therefore, contributes to the continuous development of new methods in language teaching and shows how technology has changed learning different languages. These findings can be used by educators and stakeholders to come up with effective language programs that use Education 4.0 tools and encourage active learner participation in professional communication situations.

However, there are study limitations that need to be kept in mind. Firstly, because of a small sample size, the generalizability of the findings is limited to an expanded population and the study only includes Higher Education language teachers. Another limitation is that four weeks may not be adequate for long-term effects examination after intervention. Moreover, it may not take into account other possible aspects affecting outcomes such as this study targeting only specific languages like PEC. Thus, further research has been recommended which should involve larger samples with more varied participants' characteristics, longer periods of interventions and more variables measured so as to get a full picture of what we are talking about here.

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Authors contributions

D. Sri Dhivya: Conceptualization, Methodology, Writing-Original draft, performed the statistical analysis and interpreted the findings.

K. Gurusamy: Supervision, Writing-reviewing & editing.

E. Balamurali: Visualization, Investigation.

A. Pradheepa: Coordinated data collection and analysis.

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