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Time-travelling in philosophy of mathematics courses: From classroom to newsroom

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Abstract

This article presents a new teaching method that embraces media production as a principle in education, aimed at effectively conveying the philosophy of mathematics. Based upon this premise, the content of the philosophy of mathematics course was reimagined as a digital newspaper, reminiscent of past printed editions. This transformation was carried out collaboratively with participants, shaping the course delivery accordingly. The effect of this method on the participants' technological pedagogical content knowledge was investigated using a mixed methodological approach with a sample of forty pre-service mathematics teachers. By digitally recreating historical contexts, participants had the opportunity to explore the philosophers and scientists of the relevant period, along with the social conditions they experienced. Adopting this method helped participants overcome the anachronistic epistemology fallacy, allowing them to develop their imagination and perception of the past compared to the traditional approach. It also highlights how the method transformed the class into a more engaging and entertaining part of the curriculum. Research findings reveal that creating a newspaper not only encourages the technological pedagogical development inherent in the teaching profession but also contributes to the development of the roles expected from the individual in the educational environment in the technology age. Therefore, this method may serve as a source of inspiration for teacher educators, especially those teaching courses in related contexts.

Keywords Teacher Education · Philosophy of Mathematics · Technological Pedagogical Content Knowledge · Newspaper Preparation Method

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1 Introduction

It is known that all ideas or inventions evolve through building upon one another. As it is written in Ecclesiastes 1:9 (ESV) "There is nothing new under the sun." So, nothing happens all at once. If the past of a subject remains obscure, it becomes complex, even nearly impossible, to understand its current state (Bloxham, 2022). In other words, visible phenomena represent their present condition. It is necessary to investigate the stages these phenomena went through and the ideas that were developed one after the other to reach their current state. We are even asked about our past illnesses when we see a doctor. Sometimes they also assess family history for potential hereditary diseases, spanning two or three generations. Even if this data is unavailable, a diagnosis is issued. However, if it is known, the diagnosis becomes more informed and rational. Therefore, in the study of all sciences, both natural and social, the history of every institution is emphasized, because the past serves as the foundation for the present (Kuhn, 1994; Wineburg, 2018). If the foundation is unknown, it becomes difficult to determine how many floors the building can support. That's why understanding the basics is essential. As in the example of history, in our everyday lives, certain things prove to be highly beneficial. For instance, mathematics helps us understand what is right and wrong, philosophy helps us decide what is good or bad, and art shows us what is beautiful, even in objects that might not seem appealing at first glance (Nesin, 2010). Indeed, shouldn't we teach pre-service teachers that they should spend their lives searching for truth, goodness, and beauty for the sake of setting an example for their students?

Although they might seem different, the philosophy of mathematics and the history of mathematics have several common aspects. The philosophy of mathematics (hereinafter PoM) and history of mathematics (hereinafter HoM) entail an understanding of mathematical concepts and the ability to contextualize them within a broader intellectual and historical framework (Baki, 2020; Ernest, 1991). HoM explores the growth and development of mathematics, while PoM focuses on justifying these processes in a historical and philosophical context. Thus, both fields are *interdisciplinary*, drawing on mathematics, philosophy, and history (Kjeldsen, 2010, 2011; Otte, 2007). In other words, both fields emphasize the importance of *understanding mathematics in context*. In the PoM, the logical foundations and assumptions of mathematics are critically examined (Gür, 2004). Similarly, in HoM, historical findings and inscriptions are critically analyzed to understand the development of mathematics (Clark, 2015; Larvor, 2008). Therefore, it can be said that both fields can develop *critical thinking*. Whether they desire or not, philosophers cannot disregard the historical background of mathematical improvements or act as if it never happened. So, just as history is impossible without the logical or philosophical dimension, philosophy is impossible without the intuitive or historical element. Therefore, the HoM must be understood to *obtain the truth* of the philosophy of mathematics and vice versa (Croce, 1917, p. 312) suggesting that the two fields may have a *mutual connection* (Brown, 2005, p. 11). HoM can enable one to appreciate the richness of mathematical ideas, while PoM can help one develop an insight into the abstract principles underlying this richness (Baki, 2020; Cajori, 2000; Kvasz et al., 2016; Lakatos, 1976; Larvor, 2008). Therefore, both fields have *implications for teaching mathematics*. Whether

one is primarily interested in the philosophical or historical aspects, both fields can enrich a student's understanding of mathematics (Clark, 2012; Shrestha, 2017). It can provide a *holistic perspective* on the subject and help individuals appreciate the cultural, intellectual, and historical significance of mathematics (Yıldırım, 2019). In general terms, PoM and HoM courses are essential for these reasons (Byers, 1982; Ellis et al., 2014; Ernest, 1985; Fjelland, 2022; Grüne-Yanoff, 2014). In a nutshell, it can be asserted that PoM course is inherently intertwined with the HoM, as is also proved by the credited figures in the PoM also being key figures in the HoM.

1.1 Theoretical framework

The idea of using newspapers in education is not very new and dates back to the 1890s (Cowan, 1978; Gillis, 1984). When summarizing studies on the role of newspapers in education, it can be concluded that students often find textbooks boring in comparison to newspapers (Morse, 1981; Street, 2002). However, moving the course content beyond the traditional lectures using the newspaper preparation method (hereinafter NPM) can be considered new in education. Newspaper in education is related to the use of daily newspapers as a teaching instrument in the classroom environment (Aiex, 1991; García-Carmona & Acevedo Díaz, 2016; Ramnarain & Moleki, 2017). The NPM involves synthesizing the advantages of lecturing, digital storytelling, project-based learning, and cooperative learning methods while avoiding their limitations. In brief, NPM is a teaching technique that involves taking historical and philosophical cases out of the dusty pages of history, rewriting them in a journalistic style and revitalizing them as if they were daily events (Koyuncu, 2023a). Therefore, the NPM technically differs from the use of newspapers in education. In this research, the NPM was specifically adjusted, focusing on its suitability for teaching the PoM course. Since this study aims to present an example course -PoM teaching through the NPM- the operational details are demonstrated in the implementation section.

Technological Pedagogical Content Knowledge (hereinafter TPACK), which became popular in the early 2000s, is a framework developed by Mishra and Koehler (2006) with the objective of describing the key knowledge teachers need to integrate technology into their teaching. Despite initially having served as a guide for in-service teachers, it was later demonstrated to be convenient for pre-service teachers in teacher education programs, helping them develop the necessary skills to integrate technology effectively (Chai et al., 2013; Gill & Dalgarno, 2017; Hidayat, 2019; Hsu, 2012; Sang et al., 2016; Tan et al., 2019; Zelkowski et al., 2013).

Given the TPACK framework, it consists of the intersection of three categories: *Content Knowledge (CK)* refers to the teacher's knowledge of the subject to be taught (Shulman, 1987). It means teachers must understand the basic concepts, definitions, and process flow charts of the subjects they teach and have a deep comprehension of the topics. *Pedagogical Knowledge (PK)* engages understanding how to effectively teach or convey information, merging educational and training strategies and practices (Mishra & Koehler, 2006). It refers to a teacher's understanding of teaching methods and learning strategies. For instance, knowing mathematics can be considered CK, while knowing how to teach mathematics is PK. *Technological Knowledge (TK)* can be defined as basic knowledge about the installation and use of techno-

logical equipment used by teachers, and this knowledge covers an area from blackboard to overhead projector, from computer to smart board use (Akkoç & İmre, 2015; Mishra & Koehler, 2006).

Pedagogical Content Knowledge (PCK) is the teacher's skill in blending subject knowledge with teaching methods to enhance the quality of instruction, ultimately leading to improved teaching outcomes. Technological Content Knowledge (TCK) means knowing how to use technology that helps the subject to be taught. Teachers should know how to choose the right tools for their topics in this context. Technological Pedagogical Knowledge (TPK) is knowing how to use technological tools effectively in teaching (Juniu, 2011; Koehler & Mishra, 2009; Mishra & Koehler, 2006; Sullivan et al., 2024). The Venn diagram formed by all these combinations is presented in Fig. 1.

The TPACK framework has been successfully applied in various educational contexts to integrate technology with pedagogical strategies and content knowledge (Abouelenein & Selim, 2024; Bueno-Alastuey et al., 2018; Chen et al., 2023; Jang & Chen, 2010; Lu & Lei, 2012; Rets et al., 2023; Wang et al., 2018). These studies offer valuable insights into the potential of TPACK to enhance teaching and learning, particularly in innovative instructional methods like the NPM (Koyuncu, 2023b). In summary, in this research, TPACK serves as a compass for participants in determining whom, what and how to teach through NPM. As detailed in the importance and purpose of the research section, this framework is particularly relevant to analyzing innovative teaching approaches such as newspaper production, wherein technology and pedagogy must work together to enhance content learning. Similarly, harnessing TPACK as a frame to account for the impact of the NPM lends itself to looking into the phenomenon from a multilayered lens, specifically examining the interplay

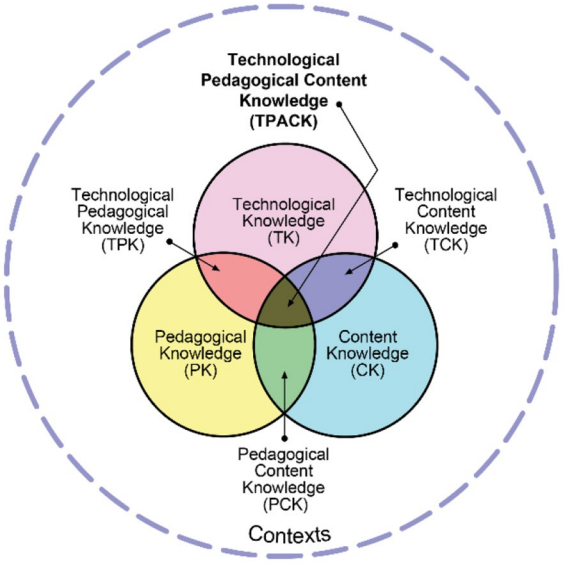

Fig. 1 TPACK Image (http://tpack.org)

across content, pedagogy, and technology competence, thereby providing informed and robust implications for pre-service mathematics teachers.

1.2 Importance and purpose of the research

Some obstacles stand in the way of teaching a philosophy of science course that includes the PoM, mainly through the use of traditional teaching methods (Fjelland, 2022). Within the traditional pedagogical framework, particularly in courses characterized by verbal content, the first and foremost learning activity involves the memorization and the retention of written text in the memory (Nesin, 2010). However, today, the roles expected from the individual in mathematics education have undergone a substantial transformation compared to the past. Modern education systems have been formed as a natural result of this paradigm shift (Bertocchi & Spagat, 2004). These educational systems intend to raise individuals who rely predominantly on experiential learning, embrace individualized approaches, and excel at utilizing digital technology, as opposed to being grounded solely in memorization (Mishra & Mehta, 2017). Moreover, although modern times are not entirely disconnected from the past, we often perceive them as distant and foreign. We learn about past events through literature and historical narratives, which can lead to a sense of alienation (Riessman, 2008). Traditional teaching methods confine developments that occurred in the past and whose effects may continue today to a distant era. This makes it inevitably challenging to comprehend the cause-and-effect relationships between the present and the past (Huai Liu, 2023). In this respect, conveying the developments in fields such as science, history, logic and philosophy together with the developments and norms in the past without isolating them from their historical roots can enable learners to comprehend these disciplines more efficiently in a cause-and-effect relationship from past to present. As detailed in the implementation process and results section of the study, the opportunities offered by information communication technologies enabled pre-service teachers to consider the works of philosophers and scientists of the relevant period alongside the political and social conditions in which these individuals lived. This method contributes to the importance of the research by addressing the concerns of Riessman (2008) and Huai Liu (2023).

Throughout the centuries, the skills demanded to deliver education have undergone radical changes during certain periods. To cultivate these skills, educational approaches have been reconsidered and developed (Gray & Horch, 2018; Koyuncu, 2020). As we move beyond the era of Industry 4.0, mathematics education should adopt the principle of empowering Generation Z and the generations that follow to create their learning environments (Hernandez-de-Menendez et al., 2020). This principle basically acts in line with the constructivist paradigm, and in this educational journey, it is desired that learners discover knowledge themselves rather than the teacher imparting the knowledge to them in a ready-made form (Cropley, 2020). As Mark Twain put it, "A lecture is a process in which information passes from the notes of the lecturer into the notes of the student without passing through the minds of either." In line with this quote, students, especially those in numerical fields, often find it tedious when someone continually presents only encyclopedic information,

which adversely affects both the audience and the speaker in this learning environment (Hativa, 2000).

Moreover, in the literature review, while studies on the significance of the PoM in curricula abound -despite its inclusion as a mandatory course- there is a noticeable lack of exploration into alternative teaching methods and materials for teaching the PoM (Fjelland, 2022; Grüne-Yanoff, 2014). As detailed in the introduction, PoM and HoM courses share common elements, making the use of NPM to teach the PoM course a reasonable endeavor. For these reasons, this study introduces a new perspective to teaching the PoM. A further practical outcome of this study is that it facilitates enjoyable, effective, and permanent learning of the PoM for pre-service mathematics teachers, offering concrete and innovative teaching material and enhancing their TPACK. In the NPM, participants may use various digital tools and *technologies* to enhance the research, collaboration, and presentation aspects of the newspaper preparation process. This involves their proficiency in using technology effectively. NPM requires participants to employ *pedagogical* strategies for group work, research, and the overall teaching process. It demonstrates how to guide students in creating a newspaper that serves the course objectives. Due to the necessity of ensuring the accuracy of newspaper content and its alignment with the course syllabus, participants using NPM need to develop a deep understanding of the PoM, which is closely related to their *content knowledge*. In summary, NPM seeks to offer a distinct approach to teaching the PoM by integrating technological tools (TK), effective pedagogical strategies (PK), and subject-specific content (CK) to enhance the educational experience. In this study, which set out with the main philosophy of contributing to improving the quality of undergraduate mathematics education, the PoM course was instructed by means of NPM and the effect of this method on TPACK of pre-service mathematics teachers was investigated. Therefore, the following research inquiries were sought out for answers:

1. How does teaching the PoM using the NPM affect the TPACK of pre-service mathematics teachers?
2. What are the pre-service mathematics teachers' opinions on teaching the PoM using the NPM?

2 Method

2.1 Research design

Studies utilizing the mixed methods approach make use of two or more different research techniques (Creswell & Plano Clark, 2015). Mixed methods, which combine quantitative and qualitative techniques, were used in this study. The explanatory design begins with a quantitative study and then incorporates qualitative research to thoroughly investigate the data obtained from the quantitative study (Creswell, 2014). Although the research, which used an exploratory design within the framework of mixed methods, covered the spring semester of 2023, the reporting and

review processes were completed in the first week of October 2023. This design not only facilitates a comprehensive analysis of quantitative data but also enriches the findings through the inclusion of qualitative insights. By employing this mixed technique design, the study aims to provide a more nuanced understanding of the research question.

2.2 Quantitative phase

Since the PoM is offered only in one of the semesters for the final year class, it was not feasible to establish a control group with matching features through random selection. Thus, the quantitative phase of the research utilized a single-group pre-posttest design. The quantitative test aimed to measure the effect of the NPM on participants' TPACK, focusing on the categories, namely technological knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, technological pedagogical content knowledge, and contexts knowledge (Fig. 1). Teaching the PoM through the NMP was defined as the independent variable, while the TPACK of the pre-service mathematics teachers was treated as the dependent variable. It is important to note that attributing the quantitative study results solely to the NPM could pose challenges. This issue is considered a constraint of this study. In this regard, to enhance the validity and reliability, qualitative data were incorporated to complement the quantitative findings (Creswell, 2014).

2.3 Qualitative phase

A case study is a research design that provides an opportunity to systematically and comprehensively examine a specific phenomenon within its real-life context (Yin, 2014). This design also allows for in-depth analysis of situations using observations, interviews, digital recordings, documents, and reports (Creswell, 2014). This method was preferred because it provides a more in-depth understanding of the research topic, complements the quantitative findings, and thus offers a more holistic perspective on the research question. The aim of the semi-structured interview used in the qualitative part of the research is thus to gain insight into the participants' opinions on teaching PoM using NPM.

2.4 Study group

The sample consists of forty pre-service mathematics teachers (hereinafter PsMT) in Istanbul. Criterion sampling involves selecting individuals or cases based on specific criteria or characteristics critical to the research question, and this method is often used in qualitative research, where the goal is to understand a particular phenomenon, group, or context in depth (Patton, 2002, p. 238). Criterion sampling can help ensure that selected individuals or cases are relevant to the research questions and can provide detailed data that will help answer the research question (A. Yıldırım & Şimşek, 2013).

Table 1 PsMT's demographic characteristics

Genders	f	%
Male	24	60
Female	16	40
Total	40	100

Hence, for this study, criterion sampling was the preferred method. Within this framework, the fundamental criteria for sample selection are outlined as follows: participants must be actively enrolled in the mathematics education program and currently undertaking the PoM course. This specific criteria-based sampling approach ensures a targeted and relevant selection of participants aligned with the study's focus. Table 1 provides demographic information about the participants who meet these criteria. The analysis of Table 1 reveals that 60% of the PsMT are male and 40% are female.

2.5 Data collection tools

2.5.1 Quantitative data collection tool

The first research question was addressed by analyzing quantitative data. In terms of research ethics, permission was obtained from the developer of the Technological Pedagogical Content Knowledge Scale, (Önal, 2016). The scale, designed to measure TPACK among PsMT, consists of 59 items categorized into eight factors and rated on a 5-point Likert-type scale. The scale's Cronbach's alpha reliability coefficient was calculated as 0.97. The number of items as well as the sub-dimensions within the scale can also be expressed as below: Technological knowledge (TK) with seven items, content knowledge (CK) with eleven items, pedagogy knowledge (PK) with nine items, pedagogical content knowledge (PCK) with three items, technological content knowledge (TCK) with three items, technological pedagogical knowledge (TPK) with twelve items, technological pedagogical content knowledge (TPCK) with nine items, and contexts knowledge (CXK) with five items. Some of the sample items in the test consisting of fifty-nine items are as follows: "I can use appropriate technologies for teaching purposes (TK)" – "I can use existing knowledge in mathematics class (CK)" – "I can use the most suitable teaching strategy to teach a particular concept (PK)" – "I can determine teaching strategies, methods, and techniques suitable for mathematics classes (PCK)" – "I can use the software available on the computer for math class (TCK)" – "I can plan how to use technology for teaching purposes (TPK)" – "I can assist others in coordinating the use of mathematics, technology, and instructional strategies (TPCK)" – "I can consider the physical conditions of the environment I will teach (CXK)".

2.5.2 Qualitative data collection tool

Qualitative data collection was employed to analyze the second question of the research. Qualitative studies frequently gather information through interviews (Patton, 2002). A semi-structured interview form developed by the researcher to collect

PsMT's opinions about learning the PoM through the NPM included the following questions: (1) Do you think the method of preparing the newspaper is useful for you? a. Probe: If so, why was it useful and in what ways was it useful? (2) What do you think are the disadvantages of the newspaper preparation method? a. Probe: What could be done to improve this method? (3) How did you feel during the lesson taught with the newspaper preparation method? (4) How did the method of preparing the newspaper affect your motivation toward the lesson?

Semi-structured interviews were initially planned with a target of thirty participants. However, due to one student's health problems, interviews were held with twenty-nine PsMTs individually in the university's library. These interviews, lasting 10–15 min, took place in June 2023, towards the end of the study. This method was opted for as it allows a deeper understanding of the topic from the participant's point of view (Strauss & Corbin, 1991). Recording the interviews provides the confirmability of the data, and it also facilitates the analysis and transcription of data (Speziale & Carpenter, 2011). Therefore, qualitative data were recorded in line with research ethics.

2.6 Implementation process

A research-based teaching strategy was implemented throughout the PsMT course, designing a dynamic and participatory learning environment to encourage active engagement. This design aimed to foster a setting where participants could actively participate and have firsthand experiences in the learning process. In summary, the aim has been to encourage PsMT to be more proactive by engaging in writing and discussions rather than just passively listening. The goal is for them to become individuals who write thoughtfully and critically rather than simply accepting information. Thus, a synergistic learning environment has been designed, empowering PsMT to manage their learning independently. The evaluation form -presented in Appendix 1- was prepared by the researcher and approved by an expert researcher in the field. Also, the application process was examined by three researchers in order to determine objectively to what extent the NPM met the teaching outcomes of the PoM course and to increase the representative power of the NPM. Two of the researchers acted as non-participant observers, keeping reports that focused on assessing the method's suitability, the course's objectives, and the evaluation and assessment processes. The participatory observer's report dwelt on the teaching environment and the interactions among the PsMT. The reports were checked to make sure they remained consistent with each other. Before starting the course, the PsMT were briefed on necessary procedures, including the aim of the method, study ethics, and task sharing. The methodology is based on the objectives, content, and outcomes of the PoM course. Instead of exams, a project-based evaluation was implemented in the course. This situation was explained to the PsMT. Accordingly, they were tasked with creating a PoM newspaper that evoked a sense of having been published in previous years. The researcher implementing this method during the course played a crucial role in guiding the PsMT who were enrolled in the relevant course. Particular attention was given to ensuring that each news article was tied to the curriculum, written in the journalistic style and that the visuals within the articles harmonized with

the written content. Newspaper pages were also categorized in accordance with the PoM course topics. Hence, the PoM course was not delivered to the PsMT through traditional lectures. Instead, they were encouraged to conduct independent research on the topics covered in the PoM course content. Since each group was responsible for writing news articles for a different page of the newspaper, specific directions were provided to each group. PsMT had the freedom to choose from all the subjects included in the curriculum. After consulting with the PsMT, it was decided to include eight pages in the newspaper, covering topics such as Logicism, Intuitionism, Formalism, Platonism, Quasi-Empiricism, Interview, Puzzle, and Caricature. The PsMT were then instructed to form groups based on their preferred page to contribute to. It was emphasized that each news item, including puzzles and caricatures, should be related to the content of the PoM course, and every text must be written in journalistic language. Since forty PsMT were enrolled in the course, ideally, five students should have taken a role on each page. However, a team of four PsMT expressed interest in preparing the caricature and puzzle, resulting in PsMT being unevenly distributed across the pages. Subsequently, each group was asked to select a page editor from within their respective groups. All group members delivered the news they wrote to their groupmates responsible for the page editing in their group. Each page editor then presented the news items on their group's page to the class. This ensured that duplicate news would not appear on different pages. Afterward, the groups assigned tasks among themselves and began reporting on the developments in the PoM, aligned with the concept of their respective pages. The PsMT updated and presented the developments in the PoM in a journalistic manner, accompanied by visually striking elements that complemented their written news. Thus, they depicted past events in the PoM as if they were daily occurrences. The page secretaries shared all the news items from their group's page with the class. This method prevented PsMT from being unaware of other developments/knowledge in the PoM, as they were solely focused on their own news. In order to enhance motivation and establish a real newspaper office environment, the PsMT were assigned various pseudo roles such as Amsterdam Correspondent, Berlin Representative, Vienna Reporter, and so forth. For instance, one of the topics in the PoM course is "Logicism". The London Reporters covered this issue by interviewing Bertrand Russell as if he were still alive. Likewise, the Amsterdam correspondents focused on L. E. J. Brouwer's contributions to mathematics on the "Intuitionism" page. As the study concluded, a *name* and "slogan" for the newspaper were conceived: *Proof* "Quod Erat Demonstrandum". As there were no distinct boundaries between the PoM and the HoM, and considering the objective of creating a newspaper that evoked a sense of being published in the past, the newspaper also incorporated connections and developments between ancient civilizations. Since the intention was to present the lesson as a real-life scenario, these additional elements enriched the overall content. In the penultimate week of the course, an agenda meeting took place to make final checks before sending the newspaper to the printing house, and all necessary corrections were made. The first copy was delivered to all PsMT, and they were asked to review it one last time and check for typographical errors. Then, the newspaper was ready for publication. As mentioned earlier, the PsMT successfully incorporated almost all structural elements of a newspaper into "Proof Newspaper", presented in Fig. 2.

Fig. 2 Sample Pages of the Proof Newspaper (Available at: https://proofnewspaper.vercel.app/)

The aforementioned processes were facilitated through a set of information and communication technologies, which can be outlined as follows: Desktop publishing software, such as Adobe InDesign, was used for designing and editing newspaper pages, while Adobe Photoshop was employed for editing and developing images. Word processing software, like Microsoft Word or Google Docs, facilitated writing and editing articles before layout. Internet research tools, like Google, were utilized for gathering information and resources for the article from online databases. Online

collaboration platforms, such as Google Drive or Microsoft Teams, supported student collaboration for writing and editing articles. Social media and online publishing platforms, like Twitter and Instagram, were used for sharing and promoting newspaper content. Additionally, digital cameras and scanners were employed for digitizing content, while tools like email and file-sharing services, such as Dropbox or Google Drive, facilitated the exchange of drafts and final versions among students and the researcher.

2.7 Analysis of the quantitative data

SPSS-25 was employed to analyze quantitative data from the TPACK scale. The analysis initially assessed whether pretest-posttest difference scores from TPACK followed a normal distribution. This involved examining Shapiro-Wilk test outcomes, skewness, and kurtosis coefficients for the TPACK scale and sub-dimensions. Results are summarized in Table 2. In accordance with Tabachnick and Fidell (2013) if the skewness and kurtosis coefficients fall within the range of ±2, it can be concluded that data follow a normal distribution. When examining the results presented in Table 2 for the sub-dimensions and the whole scale, it is observed that there are no findings with skewness and kurtosis coefficients outside the ±2 range. In summary, there is no statistically significant difference between the distribution of the difference score series and the theoretical normal distribution. In other words, the data set has a statistically normal distribution. Since the collected data met the normality hypothesis, the analysis of the data was carried out using a paired sample t-test, and the level of significance was set to 0.05. This parametric test was utilized to investigate whether there was a significant difference between these two test results within the same group (Creswell, 2014; Punch, 2005).

Since the scale has eight sub-dimensions and aims to decide the effect - if any - of these scale dimensions on the PsMT, the pre and post-test were examined according to sub-dimensions. Additionally, to comprehensively examine the effect of the NPM on the PsMT' technological pedagogical and content knowledge, a pre and post-test analysis of the entire TPACK was conducted. The conclusions derived from the analysis are presented in Table 3 under the title of Results.

Table 2 Shapiro-Wilk Test results of TPACK and the skewness - kurtosis coefficients

Difference Scores	Skewness	Kurtosis	df	p^*
Technological Knowledge	-,090	-1,00	40	,168
Content Knowledge	,108	,218	40	,913
Pedagogy Knowledge	,477	,395	40	,193
Pedagogical Content Knowledge	,337	-,997	40	,030
Technological Content Knowledge	-,072	-,901	40	,078
Technological Pedagogical Knowledge	,117	-1,02	40	,172
Technological Pedagogical Content Knowledge	,244	-,449	40	,251
Contexts Knowledge	,361	-,254	40	,241
TPACK Total Scores	,168	-,489	40	,574

($^*p<0,05$)

Table 3 TPACK paired sample t-Test results

TPACK Sub-Dimensions	Variables	*N*	X	sd	df	t	*p*
Technological Knowledge (TK)	Pre-Test	40	18.87	4.24	39	10.79	0.000*
	Post-Test	40	26.12				
Content Knowledge (CK)	Pre-Test	40	30.10	4.14	39	17.30	0.000*
	Post-Test	40	41.45				
Pedagogy Knowledge (PK)	Pre-Test	40	20.97	5.23	39	14.91	0.000*
	Post-Test	40	33.32				
Pedagogical Content Knowledge (PCK)	Pre-Test	40	7.70	2.80	39	7.65	0.000*
	Post-Test	40	11.10				
Technological Content Knowledge (TCK)	Pre-Test	40	8.55	2.42	39	6.91	0.000*
	Post-Test	40	11.20				
Technological Pedagogical Knowledge (TPK)	Pre-Test	40	33.35	5.29	39	14.10	0.000*
	Post-Test	40	45.15				
Technological Pedagogical Content Knowledge (TPCK)	Pre-Test	40	25.27	4.87	39	11.77	0.000*
	Post-Test	40	34.35				
Contexts Knowledge (CXK)	Pre-Test	40	12.75	2.82	39	13.20	0.000*
	Post-Test	40	18.65				
TPACK General Evaluation	Pre-Test	40	175.75	13.67	39	29.49	0.000*
	Post-Test	40	221.35				

2.8 Analysis of the qualitative data

The primary purpose of a qualitative study is to understand the PsMT' experiences rather than generalizations (Creswell, 2014; Patton, 2002). Furthermore, qualitative research can complement quantitative data, offering insights into potential differences and thereby enhancing the research's overall reliability (A. Yıldırım & Şimşek, 2013). Content analysis provides a detailed examination of the data, reveals previously unknown themes, but first, coding is essential for determining the content (Strauss & Corbin, 1991). In this respect, the PsMT's opinions on teaching the PoM with NPM were taken. Thus, the collected qualitative data were coded and subjected to content analysis, and four themes were formed by bringing together codes with similar characteristics. When qualitative data from twenty-nine participants was analyzed, data saturation was reached after fifteen participants and new themes no longer continued to emerge. Credibility criteria were met through persistent observation and triangulation, while transferability criteria were satisfied through purposeful sampling. According to Guba and Lincoln (1982), both internal and external validity were ensured. Internal and external reliability was established by ensuring consistency with expert opinion and confirmability with observer reports (Speziale & Carpenter, 2011). Additionally, when presenting PsMT's opinions, abbreviations (e.g. P1, P2, P3, …) are preferred instead of giving their actual names. This precaution has been taken to adhere to the principles of research ethics and to protect the confidentiality of personal information.

3 Results

3.1 Quantitative results

The change in TPACK of the PsMT before and after teaching the PoM with the NPM was analyzed by paired sample t-test, and the obtained results are presented in Table 3. As displayed in Table 3, TK pre-test result was 18.87, post-test result was 26.12 and the quantitative data obtained from the post-test result provided a significant advantage [t = 10.79; $p < 0.05$]. So, this result illustrates that the NPM in PoM teaching is effective in increasing the TK of the PsMT. By the same token, it can be inferred that the CK pre-test result was 30.10, the post-test result was 41.45, and post-test shows a notable advantage [t = 17.30; $p < 0.05$]. This result reveals that the NPM successfully increases the CK of the PsMT. In addition, since the PK pre-test result was 20.97 and the post-test result was 33.32, this result shows an obvious and substantial difference [t = 14.91; $p < 0.05$]. This result indicates that the NPM is beneficial in increasing the PK of the PsMT. Likewise, one can infer that the PCK pre-test result was 7.70, the post-test result was 11.10, and the post-test result revealed a distinct and significant difference [t = 7.65; $p < 0.05$]. That is to say, the NPM might be effective in increasing the PCK of the PsMT. In a similar vein, it can be deduced that the TCK pre-test result was 8.55, the post-test result was 11.20, and the post-test shows a notable advantage [t = 6.91; $p < 0.05$]. This result reveals that the NPM successfully increases the TCK of the PsMT. Similarly, it can be inferred that since the TPK pre-test result was 33.35 and the post-test result was 45.15, and this result show an obvious and substantial difference [t = 14.10; $p < 0.05$]. This result confirms that the NPM enhanced the TPK of the PsMT. It is also found.

that the TPCK pre-test result was 25.27, post-test result was 34.35, and post-test indicates a notable advantage [t = 11.77; $p < 0.05$]. Consequently, it could be inferred that the NPM has a beneficial impact on raising the TPCK of PsMT. By the same token, since the CXK pre-test result was 12.75 and 18.65 for the post-test, and the post-test result revealed a meaningful difference [t = 13.20; $p < 0.05$]. This indicates that the NPM helps increase the CXK of PsMT. When we look at the entire TPACK scale, it is seen that the pre-test result was 175.75, and the post-test result was 221.35. Thus, the post-test shows a notable advantage [t = 29.49; $p < 0.05$]. Therefore, it might be asserted that the NPM affects PsMT's TPACK.

3.2 Qualitative results

The second research question addressed the opinions of the PsMT regarding teaching the PoM using the NPM. The PsMT's opinions on this issue were examined using content analysis, which produced the codes and themes shown in Fig. 3. As exhibited in Fig. 3, it was determined that pre-service teachers noticed improvements in some of their skills.

These skills include research, reading, writing, self-expression, active listening, socializing, teamwork, collaboration, and time management. PsMT may have expressed these views because they demonstrated their creativity and unique voices

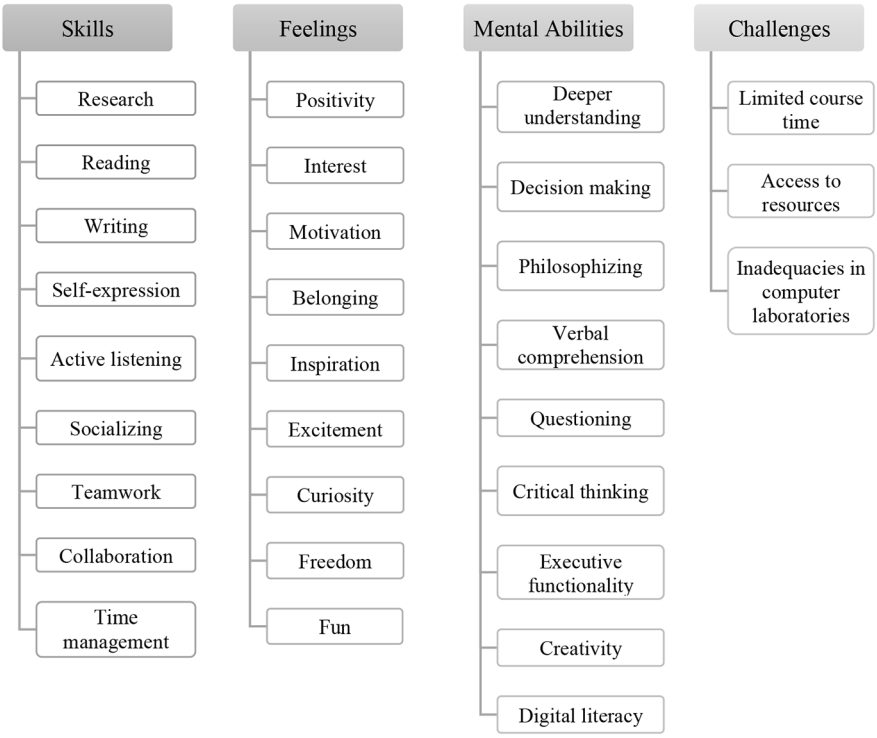

Fig. 3 Codes and Themes Obtained from Qualitative Data

while summarizing and describing the events. Here are a few statements from the PsMT in semi-structured interviews about this situation:

P7: *"Before writing the subject in journalistic language, I searched for information from books and the internet to learn more about the subject. I even read the newspapers with fresh eyes this time. I believe this helps me improve my research, reading, and writing skills"*.

P13: *"I think our generation socializes only on social media. I figured out I could socialize and express myself better outside social media. This newspaper idea has really helped us listen and understand each other. No course or environment at the university offered me this much opportunity to socialize. By socialization, I mean interactions enriched with deep philosophical discussions. These are not empty words."*

P16: *"... I think the most important key to achieving our goals was to use time effectively and to act with team spirit. It was not a task we could do alone without cooperation."*

P27: *"It would certainly be very boring if you tried to teach this course with slides or lectures, and I would probably drag my heels while attending the class. But this time, you have given us the opportunity to do research on our own, even with our friends. This was really perfect."*

Due to the use of NPM in teaching the PoM, PsMT experienced some changes in their feelings. These feelings include positivity, interest, motivation, belonging, inspiration, excitement, curiosity, and freedom. PsMT may have expressed these ideas because they saw that this course could be taught in connection with real life, established positive relationships with their peers, and developed a sense of belonging to the newspaper. As a matter of fact, the following statements obtained from the semi-structured interview form support this situation. P2: *"Since we started using this method, I've felt much more inspired and excited about coming to class. I felt like a real newspaper employee. Learning feels more interactive and fun, and I find myself looking forward to each lesson."*

P6: *"I don't remember being so curious and interested in any other course. In my opinion, all courses other than pure mathematics courses should be like this. I definitely plan to use this method with my students once I graduate. And most importantly it makes learning fun"*.

P11: *"Ever since you introduced the new teaching method, I've noticed a significant change in how much I enjoy coming to class. I used to feel bored in subjects like philosophy and history, but the new teaching method has made a difference. I look forward to class and feel more positive about our learning. It motivates me to try my best and work hard during our lessons."*

P24: *"This method made me feel like I officially belonged to this newspaper. I'm really enjoying the new way we're learning. We saw ourselves as genuine employees of a real newspaper, and I felt freer to express myself. It's like we're all part of something, and we have the freedom to learn on our own."*

According to statements from PsMT after using NPM in teaching PoM, it was observed that NPM enhanced the mental abilities of PsMT. These contributions can be listed as deeper understanding, decision making, philosophizing, verbal comprehension, questioning, critical thinking, executive functionality, creativity, and digital literacy. PsMT may have made these statements because the NPM offers a dynamic learning environment with active participation and technology.

P38: *"…I don't remember ever being so planned and organized for any lesson in my life. I realized I had very good self-control over when tasks would start and end without any delays. In addition, while discussing the news with our groupmates, we explored the philosophy of mathematics widely. We had to make logical decisions and analyze the information for the news to be consistent, accurate, and reflective of the relevant period. This helped me understand the topics more thoroughly."*

P32: *"We've learned to write more concisely and clearly. Our speaking and vocabulary have improved thanks to questioning and critical thinking about every sentence. Interestingly I'm avoiding unnecessary sentences, even when talking to a friend. I want to be able to express everything I want to say in fewer words. It's a fantastic style. You mentioned in class, 'I was going to write shorter, but I didn't have enough time.' Now, I fully understand the meaning of this statement."*

P21: *"It would seem that my philosophy teachers have been focused on teaching the history of philosophy rather than encouraging us to think philosophically. The majority of our lessons revolved around statements like 'Kant said this' or 'Hegel said that' etc. Doesn't it matter what we think? Are we only allowed to repeat Plato's thoughts? In this course, we got to express our opinions by agreeing or disagreeing*

with former philosophers by writing them ourselves. We were often expected to give definite answers in exams for other philosophy courses, and we had almost no opportunity to express our opinions."

P40: *"I remember chatting with my friends about creating something truly original and innovative. When I finish school and become a teacher, I want to do similar activities that will stimulate my students' creativity. Another thing that attracts the attention of almost all of us is that integrating digital technology in a verbal lesson so beautifully improves the computer skills of nearly all of us."*

The PsMT faced challenges while preparing the newspaper and proposed solutions to address these issues. These challenges included a lack of sufficient course time, access to resources, and inadequacies in computer laboratories. This might be explained by the PoM course's limited two lessons per week, and lack of technical equipment. Some of the PsMT statements supporting this situation are as follows:

P1: *"... teaching this lesson with this method is very impressive, but like everything I love, it was short-lived. I mean, if the duration of the course could be increased, we could definitely come up with brighter products. For example, we could have produced a short film or created a documentary in addition to the newspaper."*

P9: *"I got so caught up in the lesson that I wanted to add some passages from there to the news I wrote in the newspaper by accessing the original sources. I have access to some, but not all of them fully."*

P17: *"I understand that labs aren't typically equipped for newspaper production like ours is, but it would be ideal to have a computer lab with wide monitors for designing and planning. In fact, I would prefer to have a dedicated workspace outside the laboratory, similar to a real newspaper office."*

4 Conclusion, discussion and suggestions

NPM was applied to enrich and augment the PoM course in this study. By engaging in the production of a newspaper, PsMTs were exposed to TPACK principles through NPM. The findings suggest that this exposure can enhance students' TPACK. Since the quantitative results showed that conveying the PoM course through NPM increased the TPACK of PsMT, it was determined that the experimented method positively affected TPACK in those who attended the PoM. When qualitative data are garnered and examined to explain the result obtained from quantitative data, it is clearly seen that pre-service mathematics teachers' TK, CK, and PK have improved. TK development is attributed to including work-related tasks in the newspaper creation process, such as using the internet for research, Microsoft Office for writing and presenting, Adobe Photoshop for drawing, and Adobe InDesign for designing. Similarly, students conducted research on topics aligned with course objectives, rewrote acquired information in their own words, and structured it and consolidated the content through a two-step proofreading process after it was printed. For these reasons, the CK developed. Finally, their PK improved because they experienced and adopted an innovative teaching method. All these inferences are clearly included in the student statements. More specifically, some codes obtained from the interviews pertain to different knowledge domains. For instance, codes such as reading, writ-

ing, deeper understanding, questioning, critical thinking, philosophizing, and verbal comprehension contribute in CK; research, digital literacy, and creativity in TK; and self-expression, active listening, socializing, teamwork, collaboration, time management, decision making, and executive functionality in PK.

Tondeur et al. (2020) investigated various strategies to enrich pre-service teachers' TPACK and concluded that strategies such as acquiring technological proficiency by design and collaborating with classmates are effective in enhancing TPACK. Due to the nature of this study and as detailed in the implementation process, PsMT followed the specified strategies. Based on the findings, NPM contributed to the TPACK development of PsMT. Therefore, the results of this study align with Tondeur et al.'s (2020) findings. Indeed, by diversifying instructional activities, instructors can create a more holistic learning environment that enhances students' TPACK and prepares them for the complexities of modern educational contexts. This approach not only makes learning more engaging and effective but also equips pre-service teachers with the skills needed to integrate technology into future teaching practices. For instance, Rets et al. (2023) demonstrated that engaging, collaborative learning methods, such as virtual exchange activities, resulted in positive TPACK gains among pre-service teachers. Building on similar methods, the results of this study reveal that NPM significantly increases the TPACK development of PsMT. Therefore, this study is consistent with Rets et al.'s (2023) study, highlighting the importance of engaging and interactive approaches in teacher education.

Hofer and Grandgenett (2012), who researched which domains of teacher candidates' TPACK developed most naturally in undergraduate education and which areas needed more support, noted that pre-service teachers' TPK and TPACK improved, but there was limited progress in their TCK. Although the results of this study are parallel to Hofer & Grandgenett' (2012) results regarding TPK and TPACK, they do not resonate with those regarding TCK. Both the qualitative and quantitative results of this study show that the TCK of the PsMTs has also been enriched. This can be attributed to the fact that, thanks to NPM, PsMTs are asked to transform course content using information and communication tools.

Mezirow (1991), who introduced transformative learning theory based on the idea that people have different learning styles, focused on how students change their perspectives through critical thinking and how this leads to a more inclusive worldview for learners. In line with this theory, Mishra et al. (2011) focused on integrating interdisciplinary thinking with modern educational technologies to promote transformative learning in education and emphasized that some cognitive skills that transcend traditional disciplinary boundaries should be developed in the light of the TPACK framework to prepare students for real world problems. They listed these skills as "perceiving, patterning, abstracting, embodied thinking, modeling, playing, and synthesizing". The results of this research, as articulated by the PsMTs, contributed to a broader discourse on transformative learning by encouraging critical thinking and paradigm shift among them. Thus, it coincided with the vision of inclusive and meaningful learning mentioned by Mezirow (1991). Additionally, the study findings not only showed that participants' TPACK improved, but also contributed to the development of the skills noted by Mishra et al. (2011).

Focusing on developing and validating mathematical learning tools, including lesson plans and curricula, Putri et al. (2020) used an exploratory learning model to develop students' mathematical critical thinking skills and verified that these tools were effective and practical. Similarly, in this study, teaching methods and content were tailored to create more dynamic and differentiated learning environments using information and communication technologies such as Adobe InDesign, Adobe Photoshop, Google Drive which proved its positive impact on the TPACK of PsMTs. Thus, this research highlights the broader applicability of TPACK and provides a foundation for future studies to explore similar instructional innovations.

The statements of PsMT also strongly support the quantitative result. The qualitative results gathered the opinions of PsMT about teaching the PoM through the NPM under the following four main themes: skills, feelings, mental abilities, and challenges. Upon amalgamating both quantitative and qualitative data, it was concluded that the qualitative data substantiated the quantitative data. Thus, the results from qualitative data explained the results obtained from quantitative data and revealed the aspects of the NPM that are difficult to detect with only quantitative findings. Based on the results obtained in light of qualitative findings, it can be concluded that the NPM offers a teaching method that will meet the requirements of our age. In other words, instead of being based on memorization, NPM supports raising individuals who are completely experience-based, individualized, and can use digital technology very effectively, which was previously corroborated by several scholars. For instance, Gray (2016) and Gray & Horch (2018) stated that considering the conditions of our age and the developments in science and technology, the demand for a generation that keeps the sense of curiosity alive, thinks critically, questions, researches and is willing to invent continues to increase. Romero Ariza et al. (2024) stated that critical thinking skills are among the competencies needed in the 21st century. They also noted that teachers often apply the teaching approaches they acquired during their undergraduate education in their professional lives. Thus, they emphasized the importance of supporting this skill. In this study, the integration of information communication technologies allowed PsMTs to see tangible results of their work, which improved not only their technical skills but also their ability to critically evaluate sources and work collaboratively. Therefore, the NPM may be a valuable framework for preparing PsMTs for the demands of the 21st-century workplace. In addition, Bayode et al. (2019) and Li (2020) stated that in this era known as Industry 4.0, education and training activities should provide individuals with skills that can contribute to almost all sectors. In short, education should align with the standards of the era rather than solely creating a community of consumers (Bayode et al., 2019; Cherri, 2018). Indeed, as in the quote attributed to Benjamin Franklin, "Tell me and I forget. Teach me and I remember. Involve me and I learn", PsMT reproduced information with its thoughts and words rather than just consuming it.

In the PoM course conveyed through NPM, PsMT experienced a synergistic learning environment by being in an effective, cognitively, and physically engaging learning atmosphere. PsMT statements regarding the themes of skill and mental abilities reveal this situation. Collins et al. (2006) concluded that a synergistic learning atmosphere by being in an effective, cognitive, and physical learning atmosphere. Therefore, the findings regarding synergistic learning in this study are parallel to (Collins

et al., 2006). Fjelland (2022) and Grüne-Yanoff (2014) emphasized the deficiency of alternative teaching methods -particularly lecturing- and materials to replace the traditional methods. They even pointed out that changes should be made in the curriculum as an indirect result of this. This study aligns with the results of relevant research on the lack of effective teaching materials and the failure to move beyond traditional methods but disagrees with the interpretation regarding curriculum change. This research has shown that it is possible to go beyond conventional approaches and develop effective teaching material without modifying the curriculum. Koyuncu (2023a) developed the NPM for teaching the HoM and taught the relevant course by using this method. In the study in question, it was observed that participants gained or honed such skills as research, writing, working in teams and assuming responsibility. In addition, participants stated their motivation and enthusiasm as driven by the engaging nature of NPM, thus eradicating their pre-existing biases against the course. Finally, the NPM enhanced cognitive abilities, including critical thinking, self-directed learning, and vocabulary expansion. Considering the statements of the PsMT that constitute the qualitative findings of this study, it is evident that the results of Koyuncu's (2023a) study concur with the results of this study.

Tormey and Henchy (2008) and Evans and Matthew (2011) stressed in their study that even students who valued traditional lectures did not adopt the traditional method and rethought the standard lecture method when they encountered an unconventional teaching method. In a similar vein, in this study, PsMT expressed dissatisfaction with using lecturing methods in other courses within the curriculum, which could potentially benefit from alternative approaches. They noted boredom as a reason for not attempting to engage with these lessons. On the other hand, as is also demonstrated by the qualitative results of the research in PoM course, which was taught using the NPM, they had the exact opposite feelings. From this point of view, it can be concluded that in the verbal content courses included in the mathematics education departments, faculty members should go beyond being just "slide voicers" and should give students the opportunity to create their own learning environment. Otherwise, creating a dull learning environment may be inevitable, as in Albert Camus' analogy: "Some people talk in their sleep. Lecturers talk while other people sleep." In this respect, this study's results resonate with those of Tormey and Henchy (2008) and Evans and Matthew (2011).

In his study, Strangman et al. (2003) found that activities involving graphic organizers, similar to NPM, motivated and excited students. This research results show that PsMT experienced similar feelings through the NPM. This could be attributed to their ability to express themselves, acquire creative writing skills, and enjoy a sense of freedom in a fun and engaging manner. Furthermore, in the literature, it is underlined that teachers, school administrators and teacher educators should have the qualifications to lead in education where they are, and it is stated that they should be a source of inspiration in the work they do while carrying out this leadership (Cochran-Smith, 2003; Goodlad, 1998; Korthagen et al., 2005; Lunenberg et al., 2007). These studies highlighted the significance of establishing new learning environments in teaching practices and the importance of adapting PsMT to current needs. In short, students who graduate from education faculties should acquire these skills during their university years in order to effectively plan lessons, engage students, and inspire

them in their teaching profession. The first practical implication of this experience is that PsMT experienced such a unique teaching method. In other words, they witness an alternative approach to teaching the lesson. Subsequently, they gain an understanding of both the benefits and drawbacks of the method, which will eventually guide their actions in their professional endeavors accordingly. Imagine these skills cannot be acquired during university years. In that case, teachers risk gaining this experience at the expense of several generations in the early years of their careers, which is an undesirable situation. In this study, the concerns of the aforementioned researchers were tried to be resolved, at least partially, and an attempt was made to set a professional example for PsMT.

According to the findings, PsMT stated that they found the class duration insufficient. When the qualitative results are carefully analyzed, it can be easily deduced that this is a complaint about the rapid completion of a pleasant process. Furthermore, it is obvious that writing a concise and striking piece is a lengthier endeavor. In addition, it was observed that PsMT could not access the originals of some resources within the scope of the course and naturally stated it as a deficiency. However, PsMTs were highly motivated and engaged in the course within a fun environment. Consequently, they felt a strong sense of belonging to the class and expressed a desire for further engagement. These results may explain why they perceive this situation as a deficiency. It suffices to check the statements of PsMT to see proof for this claim. Ultimately, the insufficiency of computers, which were crucial for supporting the implementation of the NPM, proved to be a drawback. This issue was resolved with the assistance of personal computers used by the PsMT. In summary, analyses typically emphasize the strengths, weaknesses, opportunities, and potential threats of a teaching approach rather than making a definitive judgment on its overall effectiveness. In this regard, the NPM offers several strengths for PsMT in a course like PoM. It equips them with skills in creative writing, deep understanding, self-expression, philosophizing, critical thinking, and questioning. Moreover, it creates opportunities to provoke the curiosity of PsMT, motivate and entertain them, foster a sense of freedom, enhance their digital literacy, and instill the spirit of teamwork. However, it faces limitations such as the short duration of the course, difficulties in accessing original resources, and the availability of necessary technical equipment.

The literature emphasizes that writing is interconnected with thinking and plays a significant role in intellectual development. From this point on, it has been stated that gaining written expression skills in the school environment plays two fundamental roles. The first is to present and report an idea with its evidence in a planned manner, and the other is to deepen understanding and advance knowledge. Moreover, it has been pointed out that by gaining writing skills, a sustainable self-expression experience will be achieved. In this respect, written expression is among the skills that individuals must acquire in order to be successful in their careers (Applebee, 1984; Bean & Harper, 2004; De La Paz, 2005; Finkelstein, 2007; Keys, 2000; Lehrer et al., 2013; Reid & Moses, 2020; Shanahan, 2006; Wandor, 2004). Additionally, in recent years, there has been an increasing emphasis on using innovative teaching methods to develop critical and computational thinking skills in education. For instance, Zitouniatis et al. (2023) proposed a scenario-based learning methodology to teach critical and computational thinking, utilizing various information technologies

in their approach. Their findings suggest that this technique effectively facilitates learning environments. Similarly, in NPM PsMTs experienced scenario-based learning in this study. This is because, thanks to NPM, PsMTs handled the PoM content in a contextual setting with a realistic background, presented the course content in an intriguing, immersive narrative format through information and communication technologies, assumed specific roles, and exhibited active participation in the natural ecosystem of their learning environment. Thereby, based on the statements of the PsMTs, NPM enhanced their imagination and perception of the past compared to traditional methods, stimulated their natural curiosity, and made the past more accessible on a perceptual level, as is also emphasised scenario-based learning. Hence, the qualitative findings of this study indicate parallel results between both studies concerning critical thinking.

While the quantitative findings implicitly suggest the acquisition of these skills, the statements from the PsMT confirm their acquisition. Thus, we see that the results obtained in this study are aligned with those of the previous studies. Furthermore, according to Ong (2013), literacy is the culture of societies that have met writing, internalized it, and activated and remembered human memory through writing. It is for this reason that literacy allows the preservation and dissemination of knowledge through written texts, books, documents, and various forms of written media and thus plays a vital role in the development of advanced civilizations, the dissemination of knowledge and the accumulation of written records. As a result, literacy development has been a critical driver of intellectual and cultural progress. It is evident how significant a role teachers play in a society's acquisition of this culture. If teachers haven't mastered this skill, how can they effectively impart it to their students? For this reason, this study can serve as an example for both teacher candidates and teacher educators in terms of improving the literacy of society.

While this study provides evidence of the positive impact of NPM on TPACK within its context, it is essential to consider the inherent limitations -detailed in the methodology section- due to the absence of a control group and the constraints of a newly established department. Therefore, it does not attempt to generalize beyond the context. Future research addressing these limitations through extended study durations, larger and more diverse sample sizes, and the inclusion of control groups will contribute to the validity and reliability of the findings. Additionally, exploring the effectiveness of NPM in cross-cultural contexts will further our understanding of its impact on teaching competencies.

Appendices

Appendix 1 Evaluation form

Criteria	Score
Alignment with the curriculum	20
Clarity, conciseness, and attention-grabbing	20
In journalistic style	20
Appropriateness of visuals	15

Appendix 1 Evaluation form

Criteria	Score
Adherence to spelling and orthographic rules	15
Collaborative Effort	5
Meet Deadline	5
Total	**100**

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Declarations

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Competing interests The author reports no declarations of interest.

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