



Research paper

Research themes and trends in the field of teacher educators: A topic modelling study

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ABSTRACT

This study identified research themes in the field of teacher educators using topic modeling analysis and explored their trends over time. A dataset of 754 scientific publications from Scopus was analyzed with Latent Dirichlet Allocation approach. The findings revealed ten distinct research themes, covering pedagogy/knowledge, social justice, collaboration, identity, professional growth, policy, practice, quality standards, English language and technology competency. Thematic research trends exhibited periodic and consecutive patterns since the 2010s. The findings discussed the identified themes relative to existing review studies as well as trends considering the impact of education journals, educational policies and reforms initiatives, and Covid-19 pandemic.

1. Introduction

Teacher educators (TEs) are pivotal in preparing pre-service teachers and fostering the professional development of in-service teachers. Although critical to the domain of teacher education, TEs did not receive substantial research attention until the early 2000s (Livingston, 2014). Initial studies during this period concentrated on various aspects such as the preparation processes of TEs (Cochran-Smith, 2003), the challenges and adaptation during their transition to TE roles (Murray & Male, 2005), and the exploration of TE identity (Bullough, 2005). These and other related studies (see Murray, 2005) underscored that the TE field was underexplored and lacked robust theoretical underpinnings. Consequently, both general and field-specific education journals have recognized the need for a more comprehensive exploration of TEs, as evidenced by the increase in special issue calls from the early 2010s to the present (e.g., Brown & Coles, 2010; Knight et al., 2014; Krainer et al., 2021; Slykhuus et al., 2019).

The perceived research gap and repeated calls for further study over more than two decades have led to significant scholarly output. Hangul et al. (2022) conducted a bibliometric analysis of 882 scientific publications on TEs and observed an exponential growth since the 2000s. They also noted a significant increase in publications indexed in the Web of Science, from 1 to 7 in the early 2000s to over 100 by 2020.

Furthermore, they determined that the average duplication period for scientific production in this field was approximately 3.5 years. These findings emphasize the vast expansion of scholarly work within the TE field, which has recently been recognized as an autonomous research domain (Tack et al., 2018).

The rapid growth in scientific output has led to the emergence of a substantial body of work regarding TEs, previously described as "hidden" or unrecognized professionals (Livingston, 2014, p. 219). This surge brings with it the need to synthesize scientific production within the field. Several systematic or scoped review studies have been conducted to this end (e.g., Hinojosa-Paredes, 2020; Phuong et al., 2018; Ping et al., 2018), providing valuable insights and designating key research findings in particular aspects of TEs.

Despite these valuable efforts, there remains a significant gap in content analyses of the extensive scientific productions using automated computational methods to perform a comprehensive exploration of TE research themes and trends. This study aims to bridge this gap by employing probabilistic topic modeling to analyze a corpus of 754 scientific publications. This method helps identify core research themes and track their evolution, and hence offers a broader perspective on the field. The study will thus address the following research questions:

1. What are the emerging research themes in TE studies?

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2. How do the research interests (or trends) in these themes change over time?

This study is expected to make three key contributions. First, it will use topic modeling to reveal the latent research themes that shape scientific production in TE field, identifying both focal points and gaps in research efforts. Second, as established by [Hangul et al. \(2022\)](#), TE research is currently experiencing a phase of proper exponential growth. According to [Price and Tukey \(1963\)](#), during such a phase, research topics are refined in detail, leading to new discoveries and rapid advancements within the field. In this dynamic phase, our study will provide researchers with critical insights that facilitate the alignment of their research with the evolving focal points within the TE field. Lastly, the study will offer a comprehensive and holistic view of the evolution and direction of the TE field. This will enable researchers to establish meaningful connections between various research questions and their outcomes, thereby enhancing their ability to draw rich and insightful inferences.

2. Background and related research

This section delves into three key areas: describing the target TE population, summarizing the existing literature on research themes within the TE field, and providing background on topic modeling.

2.1. Who are teacher educators?

The definition of TEs is crucial for clarifying our research focus. TEs are generally recognized as "teachers of teachers" ([Lanier & Little, 1986](#), p. 528) who are responsible for teacher qualifications. [Dengerink et al. \(2015\)](#) provide a more comprehensive definition, describing TEs as both induction tutors and mentors in schools—responsible for on-the-job training and development, including the practicum process—and as academics in higher education institutions tasked with teacher education, continuous professional development, research, subject studies, and didactics. This description distinguishes between two primary categories of TEs: university-based and school-based, a common distinction found in the literature.

Regarding the first category, university-based TEs, also known as higher-education TEs ([Czerniawski, Guberman, & MacPhail, 2017](#)), are prominently featured in research. [White \(2019\)](#) notes that the majority of studies have focused on those educating within tertiary settings. [Griffiths et al. \(2010\)](#) identify two sub-groups within this category: those entering from a school background as classroom teachers, and those from academic or research disciplines. The criteria for higher-education based TE positions vary globally; for example, in the Netherlands and Australia, securing a higher-education role typically requires teaching experience or a postgraduate research degree ([van Velzen et al., 2010](#)). Similarly, in the UK, TEs generally have prior teaching experience ([Boyd, Harris, & Murray, 2007](#)), while in Finland, they are often academics expected to hold a doctorate ([Krokfors et al., 2011](#)).

The second category includes school-based TEs, often referred to as cooperating teachers or mentors within schools. As noted by [White \(2019\)](#), this term is relatively new, and the associated literature primarily discusses the roles of school-based TEs in mentoring or supervising, rather than the pedagogy of teacher education. [White and Forgasz \(2017\)](#) explore the dual roles of these educators, both as teachers and mentors. They argue that school-based TEs, similar to their university counterparts from teaching backgrounds, face the added challenge of educating children while simultaneously training adults.

[White \(2019\)](#) also refers to a third category, termed 'community-based' TEs which includes parents, community leaders, and Indigenous Elders in countries like Canada and Australia ([Zeichner et al., 2016](#)). This group plays a crucial role in equipping teachers to understand and appreciate social and cultural diversity, possessing valuable 'funds of knowledge' that are essential for addressing the varied learning needs of

students ([González et al., 2006](#)). In this study, we inclusively define TEs to encompass all three groups, ensuring a comprehensive examination without excluding any segment from our scope.

2.2. Research themes in TE field

In TE research, we have identified eight review studies that attempt to synthesize the existing literature on TEs. These review studies focus on diverse aspects and contexts related to TEs. The common themes identified across different reviews are informative in terms of potential research themes. [Table 1](#) provides concise descriptions of these reviews, including their foci, timespans, methods, datasets, and the identified research themes.

Despite the diversity of foci, recurring themes are apparent across different reviews. One such theme is identity, which has been the subject of an independent review by [Izadinia \(2014\)](#). Additionally, identity has frequently been addressed in other studies, as noted by [Saito \(2013\)](#) in relation to the challenges faced by novice TEs, and by [Phuong et al. \(2018\)](#) within the context of faculty development activities.

Another significant theme is professional learning/development, which was the focus of a distinct review by [Ping et al. \(2018\)](#), featured prominently in the review conducted by [Hinostroza-Paredes \(2020\)](#) in the context of professional agency, and was also emphasized by [Yuan et al. \(2022\)](#) in the field of TESOL. These themes of identity and professional development were also identified among the emergent research foci by [Hangul et al. \(2022\)](#) in their analysis of 882 TE-related studies.

Two of the review studies presented in [Table 1](#) adopt a field-specific perspective: [McEvoy et al. \(2015\)](#) focus on Physical Education, and [Yuan et al. \(2022\)](#) on TESOL, both highlighting themes of teaching/pedagogy and knowledge. These themes were also featured under TE's professional learning by [Ping et al. \(2018\)](#) and within faculty development activities by [Phuong et al. \(2018\)](#).

Another recurring theme is collaboration, which [Izadinia \(2014\)](#) linked to identity development and supportive relationships within the learning community. In the domain of physical education, [McEvoy et al. \(2015\)](#) emphasized TEs' collaboration in working with teachers, schools, and communities. Similarly, [Ping et al. \(2018\)](#) highlighted this theme prominently in relation to professional learning activities.

Social justice is another discernible theme, noted by [Hangul et al. \(2022\)](#) as having gained increasing research interest in recent years. [Hinostroza-Paredes \(2020\)](#) emphasized social justice as a factor influencing professional agency. Likewise, the theme of technology integration, observed as a rising trend by [Hangul](#), was a significant theme in [Phuong et al.'s \(2018\)](#) review of faculty development activities.

Adaptational challenges, often associated with novice or transitioning TEs, are also frequently reported. [Saito \(2013\)](#) and [Izadinia \(2014\)](#) identified a similar set of challenges experienced by this group. [Ping et al. \(2018\)](#) linked these challenges to role transitions within the context of professional learning. The final theme we observe involves aspects of TE practice, such as teaching ([Hangul et al., 2022](#)), practicum supervision ([Yuan et al., 2022](#)), and instructional activities ([Phuong et al., 2018](#)).

Special issue calls are also informative because they facilitate the creation of thematic collections that shed light on specific areas of interest. We identified nine different special issue calls, as presented in [Table 2](#). Some of these calls resonate with themes identified in the review studies, including professional development, knowledge, identity, practice, and technology competencies.

Drawing upon diverse review studies and special issue calls has provided preliminary insights into potential research themes. However, to ensure that these themes are representative of the broader scholarly discourse and to discover any themes not yet highlighted, a more systematic and comprehensive examination of the literature is required. Furthermore, although the timespans of the review studies offer some understanding of the trends within certain research themes, there

Table 1
Review studies in TE research.

Authors	Review focus	Timespan	Methods	Dataset	Identified themes
Saito (2013)	Challenges faced by novice TEs	Not specified	(literature review) Overview	47 articles	<ul style="list-style-type: none"> • Identity transition • Fear of research • Adjustment to work environment
Izadinia (2014)	TEs' identity	2004–2014	Overview	52 articles	<ul style="list-style-type: none"> • Challenges <ul style="list-style-type: none"> o Adaptational o Emotional • Factors impacting on identity development <ul style="list-style-type: none"> o Self-support o Community support • High quality induction programs <ul style="list-style-type: none"> o Learning communities o Supportive relationships o Reflective activities o Research
McEvoy et al. (2015)	Physical education TEs	1990–2014	Scoping review	96 articles	<ul style="list-style-type: none"> • The themes addressed in Physical education TEs <ul style="list-style-type: none"> o Demographics o Biographies o Socialization o Knowledge o Perspectives o Professional contexts o Role expectations o Working with teachers, school and communities o Pedagogies o Research
Phuong et al. (2018)	Faculty development for TEs	2005–2015	Systematic review	22 articles	<ul style="list-style-type: none"> • Foci of faculty development activities <ul style="list-style-type: none"> o Technology integration o Pedagogical skills o Instructional activities o Teaching in English Language o Social virtual environments o Identity development o Research productivity
Ping et al. (2018)	TEs' professional learning	2000–2015	Systematic review	75 articles	<ul style="list-style-type: none"> • Content <ul style="list-style-type: none"> o Pedagogy o Knowledge o Research o Identity • Activities <ul style="list-style-type: none"> o Academic engagement o Collaboration o Professional development programs o Reflections • Reasons <ul style="list-style-type: none"> o External requirement o Personal ambition o Role transition
Hinojosa-Paredes (2020)	University TE's Professional Agency	2007–2019	Scoping review	28 articles	<ul style="list-style-type: none"> • Factors impacting on professional agency <ul style="list-style-type: none"> o Education policies, o Professional development o Identity o Social justice
Yuan et al. (2022)	TEs in the field of TESOL	2010–2020	Systematic and critical review	69 articles	<ul style="list-style-type: none"> • Professional engagement <ul style="list-style-type: none"> o Teaching o Practicum supervision o Research • Cognition <ul style="list-style-type: none"> o Beliefs, perceptions and attitudes o Knowledge and expertise • Learning and Identity <ul style="list-style-type: none"> o Institutional and individual efforts o Identity and professional development
Hangul et al. (2022)	Topical foci in TE research	1967–2021	Bibliometric analysis	882 articles	<ul style="list-style-type: none"> • Professional development/learning • Critical pedagogy, social justice, diversity, and equity • Technology integration • Identity • Teacher knowledge and teaching

remains a need for a detailed analysis to reveal how these themes have evolved over time. To address these needs, this study will first employ topic modeling analysis to identify prevalent research themes followed by time series analysis to track the evolution and trends of these themes.

2.3. Topic modelling

Topic modeling represents a significant advancement in the field of machine learning, particularly for exploring semantic patterns within

Table 2
The special issue calls on teacher educators.

The journal	The call	The topic
Journal of Mathematics Teacher Education (JMTE)	Reid and Zack (2010)	Mathematics teacher and mathematics teacher educator change—insight through theoretical perspectives
Journal of Teacher Education (JTE)	Knight et al. (2014)	Professional development and practices of teacher educators
Mathematics Teacher Education and Development (MTED)	Muir et al. (2018)	Engagement and impact: a focus on mathematics teacher educators' studies into practice
JMTE	Beswick and Goos (2018)	Mathematics teacher educator knowledge: what do we know and where to from here?
Journal of Technology and Teacher Education (JTTE)	Slykhuus et al. (2019)	The teacher educator technology competencies: so what? now what?
The Mathematics Enthusiast (TME)	Appova et al. (2020)	Supporting mathematics teacher educators' knowledge and practices for teaching content to prospective (grades k-8) teachers
Journal of Mathematics (JM)	Montes (2021)	Mathematics teacher educators' knowledge, identity, and professional development
International Journal of Science and Mathematics Education (IJSME)	Krainer et al. (2021)	Teacher educator professional growth
JMTE	Helliwell et al. (2023)	Researching the expertise of mathematics teacher educators in initial teacher education settings

large, unstructured collections of text. This method, which falls under the broader category of text mining, enables the exploratory analysis of vast numbers of scientific publications using unsupervised machine learning techniques with relatively minimal time investment (DiMaggio et al., 2013). A prominent method used in topic modeling is Latent Dirichlet Allocation (LDA), which has gained widespread adoption in recent years (Blei, 2012). Blei et al. (2003) discuss LDA as a primary approach that encompasses a fully Bayesian statistical paradigm for modeling the semantics (content) of topics. LDA probabilistically predicts the topics present in a document (Blei et al., 2003). The goal of the LDA algorithm is to model a comprehensive representation of the corpus by uncovering latent content variables called topics. This algorithm operates on the principle of distributional semantics (Turney & Pantel, 2010) and relies on the bag of words assumption, where the thematic structure of a document is understood through its word distribution (Grimmer & Stewart, 2013). LDA's ability to identify main thematic clusters in large text corpora and model hidden structures embedded within texts makes it a valuable tool to map out the major research themes in a particular field of study. Hence, we employ LDA to analyze the scientific literature within TE field to ascertain prevalent research themes.

3. Method

To identify research themes and trends, a four-stage method was employed, as depicted in Fig. 1. The first stage involved creating a dataset by selecting relevant scientific publications. In the second stage, preprocessing tasks were carried out to prepare the dataset for analysis. In the third stage, an LDA-based topic modeling analysis was conducted

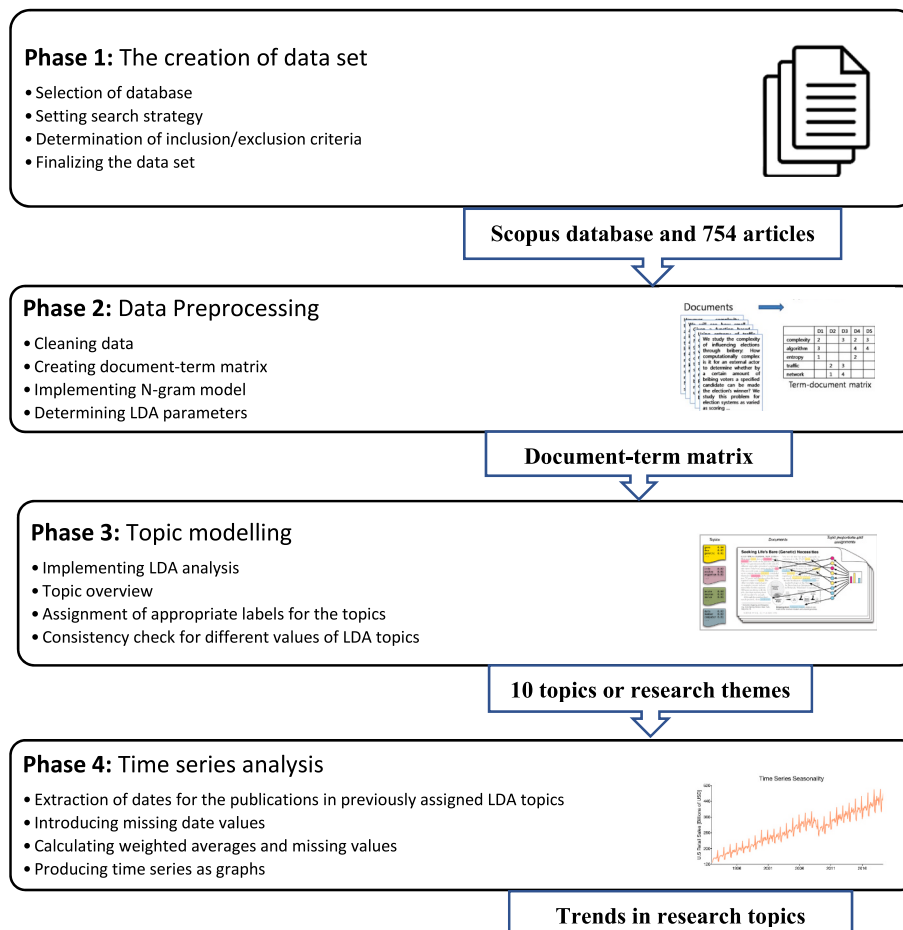


Fig. 1. Design of method.

to identify research themes. Subsequently, time series analysis (TSA) was performed to observe the trends within these themes.

While conducting the TSA and LDA analyses, we utilized KNIME, an open-source data mining software. Villarroel Ordenes and Silipo (2021) note that KNIME offers substantial advantages over other tools like Python, SAS, RapidMiner, R, Alteryx, and AzureML. KNIME's open architecture allows for customization of data analysis workflows to meet specific research needs. It also provides diverse data visualization tools for interpreting results during clustering processes. For this study, the research team developed custom algorithms for the analyses, which are shared as open source on a data repository.

3.1. Creation of data set

In this study, we chose to analyze scientific publications retrieved from the Scopus database, guided by several key factors. Firstly, Scopus is widely recognized alongside Web of Science (WoS) as not only reliable but also comprehensive database, providing high-quality data for research evaluations (Harzing & Alakangas, 2016; Vera-Baceta et al., 2019; Zhu & Liu, 2020). Secondly, Scopus offers more extensive coverage than WoS, including a broader scope of journals (Mongeon & Paul-Hus, 2016). Thirdly, Scopus continuously re-evaluates the appropriateness of new and already indexed titles, actively excluding poor-quality and 'predatory' journals and publishers, which pose a growing threat to the integrity of scientific research (Baas et al., 2020). Given its comprehensive nature, and to include a larger number of scientific publications in our analysis, we opted to use the Scopus database for our study.

The publications were selected using the PRISMA technique (see Moher et al., 2009) in four stages: identification, screening, eligibility, and inclusion. During identification, a search was conducted in the Scopus database for English-language articles, books, book chapters, reviews, and conference papers. These publications comprised research works with full-text access in the fields of social sciences, arts and humanities, mathematics, and psychology. Moreover, all studies conducted within the time range from 1942 to December 2022 were included, with no restrictions on the publication year.

Our search strategy involved specifically entering the term "teacher educator*" in the "article title" field within the Scopus database. The rationale for selecting "teacher educator*" as the key search term is based on its established use in scholarly discourse, which encompasses the three groups of TEs identified in our literature review: higher-education based, school-based, and community-based. By limiting our search to this term, we aimed to capture studies that explicitly discuss any of these groups, thereby ensuring that our dataset comprehensively represents the breadth of research focusing on TEs.

To ensure relevance, we restricted our searches to article titles. Preliminary investigations showed that including abstracts and keywords often led to numerous results where TEs were mentioned incidentally rather than as the main focus. For instance, many studies targeting pre-service teachers indirectly addressed TEs, potentially diluting our dataset's thematic focus. Maier et al. (2021) highlight that including such peripheral studies can threaten the validity of LDA analyses. Hence, we refined our search strategy to include only the most pertinent studies, avoiding the inclusion of less relevant research.

Our search strategy initially yielded a total of 1715 studies. To ensure the relevance of our dataset, two of the authors, both members of the full analysis team, collaborated closely to apply the inclusion and exclusion criteria developed collectively by all authors (see Table 3 for criteria). Each publication was initially screened independently by these two members to maintain an unbiased approach. Subsequently, their assessments were compared, and any discrepancies were resolved through discussions until a consensus was reached by the entire analysis team.

During the screening process, 79 publications such as editorials, errata, and brief reports were excluded as not meeting our inclusion criteria. Additionally, 30 publications were excluded as they fell within

Table 3
Selection criteria for the publications.

Inclusion criteria (IC)	Exclusion Criteria (EC)
IC1-Database: Scopus IC2-Scope: Teacher educators	EC1-Database: Other than Scopus EC2-Scope: Other than teacher educators
IC3-Document types: Articles, books, book chapters, reviews, conference proceedings	EC3-Document types: Editorials, notes, erratum, brief reports
IC4- Subject field: Social sciences, arts and humanities, mathematics, psychology	EC4-Subject field: Others (e.g., Computer sciences, medicine, engineering, and accounting)
IC5-Publication stage: Published (including online first)	EC5-Publication stage: Pre-publication
IC6-Language: English	EC6-Language: Other than English
IC7-Full-text: Full-texts available	EC7-Full-text: Full-texts unavailable
IC8-Duplicates: Listed one	EC8-Duplicates: Listed more than one
IC9-Abstract: Those with the abstracts	EC9-Abstracts: Those without abstracts
IC10-Keywords: Those with key words	EC10-Keywords: Those without key words

unrelated subject fields like computer science, medicine, and healthcare professions. Furthermore, 54 publications were in the pre-publication stage and 35 were produced in non-English languages. Hence, they were excluded. After applying these screening procedures, 1517 studies remained for further consideration.

In the eligibility phase, studies that were not available as full-text ($n = 304$), duplicates in the search list ($n = 8$), or irrelevant to TE research, such as announcements, withdrawn conference papers, or symposium schedules ($n = 41$), were also dismissed. Consequently, 1164 studies remained after this eligibility check. In addition, 138 studies lacking abstracts and 272 studies lacking keywords were excluded. Ultimately, the dataset comprised 754 scientific publications. The details of the selection process using the PRISMA technique are presented in Fig. 2.

3.2. Data pre-processing

Our dataset of 754 scientific publications was uploaded to the KNIME data mining program as an Excel file. We conducted several pre-processing tasks to prepare the data for LDA analysis. Initially, we used a preprocessing algorithm within KNIME to clean the data. This algorithm removed stopwords, punctuation marks, abbreviations, and unnecessary numbers, standardizing the text to uniform case (all lowercase or uppercase). Subsequently, we generated a document-term matrix essential for topic modeling. This involved creating word vectors for each publication using the bag of words method (Grimmer & Stewart, 2013), which captures the frequency of each term across documents. Tokenization, the process of breaking text into words, was the initial step in constructing this matrix, reducing matrix size and enhancing analysis efficiency (Jacobi et al., 2016). Additionally, we applied lemmatization to reduce words to their base forms using a dictionary of inflection rules, thus streamlining the grouping of related words under relevant topics.

To identify high-frequency terms, we utilized the N-gram model at the word level. The N-gram model refers to groups of consecutive words that convey contextual meaning better than individual words. Technically, it poses a challenge for LDA to analyze and determine consecutive words. However, Wang et al. (2007) proposed a method for computing the N-gram topic model, which we employed in the analysis algorithm of this study. This framework assigns a combination of topics to both individual words and N-gram phrases. Applying the LDA model to each word in a document group individually is computationally demanding (in terms of time) and impractical, as most words do not significantly contribute to the topics. For instance, common words like "the" and "have" can be found in every document, irrespective of the topic. To filter out very rare or very common words, we employed tf-idf (term frequency-inverse document frequency). The obtained data was then combined with POS tagging for further analysis.

Stages	Inclusion	Exclusion
Identification	Publications extracted from the Scopus database with the search strategy in December 2022 (N=1715)	*EC1: Database
Screening	Filtering the publications obtained through title search (N=1517)	*EC3: Document type (n=79) *EC4: Subject field (n=30) *EC5: Publication stage (n=54) *EC6: Language (n=35)
Eligibility Assessment	Detailed examination of publications through abstracts (N=1164)	*EC7: Full-text (n=304) *EC8: Duplicates (n=8) *EC2-EC3: Scope and document type (n=41)
Inclusion	Finalisation of dataset with selected publications (N=754)	*EC9: Abstracts (n=138) *EC10: Keywords (n=272)

Fig. 2. Schema of the dataset creation using PRISMA technique.

Topic modeling offers an important advantage in that it eliminates the need for pre-coding schemes. However, certain parameters must be predefined. Specifically, determining the number of topics (K) that the LDA model should assign to words in the documents is crucial. This K value represents the optimal number of topics and poses one of the main challenges in topic modeling. To address this, we conducted Perplexity analysis on the dataset, as suggested by Blei et al. (2003). The graph of perplexity K topics is shared in Fig. 3.

According to the graph, the number of topic ranges from 2 to 80. Maier et al. (2018) suggest that the optimal number of topics in a perplexity-K topics graph is determined by identifying significant changes, often marked by the first abrupt break, known as the ‘elbow method’ (Dewi & Thiel, 2017). Upon examining the perplexity graph, points at 6, 10, and 15 show significant changes. In our LDA analysis using KNIME, we can manually set the number of topics, allowing for specific topic-word distributions to be created. Following literature recommendations (Dewi & Thiel, 2017), topic distributions between 6 and 15 were explored separately. Multiple trials by the research team across these distributions revealed that a maximum of 10 topics meaningfully aligned with the data. Consequently, the optimal number of topics, K, as estimated from the perplexity graph, was determined to be 10.

In addition to K, two other prior parameters, α and β , need to be assigned for optimizing the LDA model (Blei, 2012). The parameter α refers to the number of topics assigned per document, while β represents

the word distribution per topic. In LDA modeling studies on scientific publications, it is widely recognized (Jacobi et al., 2016) that assigning $\beta = 0.01$ and $\alpha = 50/(\text{number of topics})$ yields a fine description of topic distributions. Consequently, we adopted these values in our study.

3.3. Topic modelling

Following the pre-processing tasks on the scientific publications in the dataset, to address the first research question, we conducted LDA-based topic modeling analysis using an algorithm developed within KNIME specifically for this purpose. The algorithm serves three main functions simultaneously. Firstly, it creates a mapping that shows how the studies are clustered under the identified topics, providing a visual representation of their assignment and distribution. Secondly, it generates a probabilistic list of key terms that are indicative of each topic based on their frequency of occurrence. Lastly, for each scientific publication in the LDA analysis, a list of topic probabilities is obtained. The publications are ranked based on the highest probability and their distribution among the potential topics is determined accordingly. Please note that a publication is associated with multiple topics as the LDA algorithm considers the probabilistic distribution for each item in the dataset.

In the LDA analysis, the degree of association between each word and the topics is calculated. This calculation assigns a weight to each word in each topic. The variables used in this calculation are as follows: the size of the dictionary formed from all words in the dataset, the distribution of words in a specific document, and the number of times the relevant word is assigned to topics across the entire document (see Güven et al., 2019). To find the topics of the documents, the same procedures are applied to every word in all documents in the dataset. After the topic distributions of the words are determined, a document-term matrix is created to extract the system model. Using this matrix, the weights of the words and publications assigned to a particular topic are calculated. These weights provide useful indicators while developing the description of identified topics with appropriate labels (Asmussen & Møller, 2019).

3.4. Time series analysis (TSA)

To address the second research question, we conducted TSA on scientific publications associated with the topics identified through LDA. This analysis, carried out in KNIME, followed a customized workflow inspired by Weisinger et al. (2022). It involved preprocessing data from

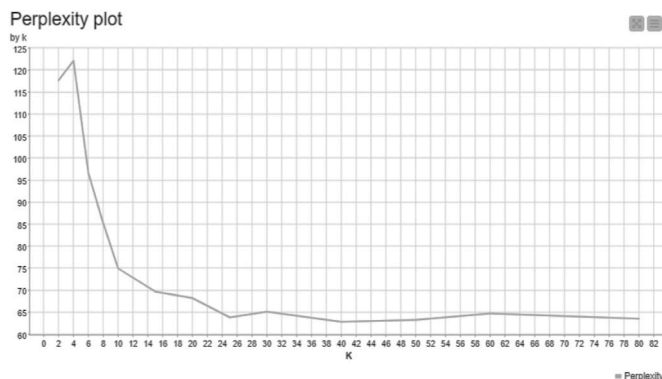


Fig. 3. Perplexity K topics.

the Scopus database, including correctly assigning publication dates to each dataset entry for accurate temporal representation. The datasets for TSA, outputs from our previous LDA analysis, were weighted based on their relevance within thematic clusters. This structured data then underwent regularization and cleaning in KNIME to ensure it was evenly spaced and continuous.

A common challenge in TSA is handling missing data, which could distort trend analysis and lead to inaccurate interpretations. To address this without disrupting the dataset continuity, we applied a fixed-value technique for missing data imputation, as recommended by Weisinger et al. (2022). This approach involved assigning a zero value to missing data points, a method suited to our dataset characteristics. This imputation was implemented through the Missing Value node in KNIME, utilizing pre-configured codes to ensure uniformity across the dataset and maintain an evenly spaced time sequence.

For visualizing the time series data, we employed line plots. These plots present the observed values (average weights of articles for each topic) on the vertical axis (y-axis) and time on the horizontal axis (x-axis). By connecting successive values with straight lines, we emphasized the data's continuity over time and the chronological order of observations. Line plots effectively reveal the long-term behavior of the time series, provide insights into data quality, and highlight topics that require further investigation.

3.5. Reliability and validity

In machine-based content analysis techniques, reliability is often not considered a major concern (Maier et al., 2018). Yet, some scholars emphasize the importance of multiple field studies using identical datasets and parameters to demonstrate empirical robustness (DiMaggio et al., 2013; Levy & Franklin, 2014). Transparency is critical in this context. To enhance transparency and ensure the replicability of our study, we have shared the dataset, publications assigned to topics, KNIME workflows, and customized algorithms in a data repository as supplementary materials.

Ensuring the validity of assigned labels for identified topics is a significant concern in topic modeling studies. To minimize the risk of mislabeling, we adhered to recommendations on the labeling process (Elgesem et al., 2016; Maier et al., 2018) and reviewed practices in other topic modeling studies (e.g., Chen et al., 2020; Inglis & Foster, 2018). Based on these insights, our topic labeling process involved three stages: (1) term and publication analysis, (2) label deliberation and preliminary assignment, and (3) validation.

The initial stage focused on examining the key terms associated with each topic and highly representative sample documents, determined by their weight. This analysis helped identify key research aspects addressed by the documents within each topic cluster. We considered these key aspects, along with a combination of key terms and publication titles, to establish a preliminary semantic foundation, setting the stage for generating labels.

In the second stage, following Chen et al. (2020), we adopted a collaborative and iterative method. Our research team engaged in intensive discussions, contextualizing initial label choices with insights from TE literature. Through reflective and critical dialogue, we explored alternative labels for each topic, ultimately selecting those that most accurately captured the essence of the associated documents and key terms, achieving consensus among the analysis team.

The final stage involved validating the labels, a crucial step in accurately representing intricate research themes (Maier et al., 2018). Following Asmussen and Møller's (2019) recommendations, we implemented several semantic validation strategies. Initially, we ensured the labels aligned with established academic discourse by comparing them against themes from systematic reviews and special issue calls. We also sought feedback from two field experts to confirm the accuracy and relevance of our labels. Additionally, our team held multiple meetings, following suggestions from Maier et al. (2021) and Jacobi et al. (2018),

to review each label's semantic alignment and contextual appropriateness. Through this process, we aimed to ensure that our topic labels were not only semantically valid but also resonant with broader academic discourse on TEs.

4. Findings

In alignment with our research questions, this section is organized under two headings. First, we present the research themes identified through LDA topic modeling. Second, we share the results of the TSA and the observed trends in research topics.

4.1. Research themes extracted through topic modelling

This section presents the ten themes identified through LDA topic modeling. The distribution of keywords within each theme and their respective weights is displayed in Table 4. We elaborate on the key aspects of research grouped under each theme and explain how the associated terms relate to these key aspects. Based on these considerations, we also introduce the labels for each theme.

4.1.1. Topic 1: field-specific knowledge and pedagogy

The first topic represented the largest cluster identified in our study and encompassed 104 publications, accounting for 13.79% of the entire dataset. The research within this topic has three key aspects. Firstly, the publications under this topic are specific to particular fields or disciplines such as mathematics education (Chick & Beswick, 2018), science education (Mork, 2021) and physical education (Backman et al., 2019). Secondly, there is a strong emphasis on various field-specific knowledge domains such as content knowledge (Backman et al., 2019) and understanding of how students learn within specific subjects (Pascual et al., 2021). Thirdly, the focus extends to the pedagogical approaches that TEs employ or require for effective teacher preparation, as discussed in publications like those by Chick and Beswick (2018).

These three aspects are closely aligned with the key terms associated with this topic, such as "knowledge," "pedagogy," "teacher-education," "teacher-educator," "science," "mathematics," and "education." These terms collectively highlight the triple focus of the topic: TEs' specialization in particular fields, their field-specific content knowledge, and pedagogical strategies for teacher education. Based on these observations, we named this topic "Field-specific knowledge and pedagogy" which succinctly captures the triple focus present in the clustered studies.

4.1.2. Topic 2: diversity and social justice

The second topic encompassed 85 documents, making up 11.27% of our dataset. The studies under this topic analyze TEs' preparedness (Lunn Brownlee et al., 2019), self-efficacy (Brant & Willox, 2020), knowledge (Ohito, 2019), awareness (Stillman et al., 2019), perspectives (Salvador & Kelly-Mchale, 2017), and experiences (Menna et al., 2022) in handling issues related to diversity and social justice. These works often adopt critical perspectives on how TEs navigate, comprehend, and implement inclusive and equitable strategies within educational settings.

These key aspects resonate with the assigned terms under this topic. The terms "critical," "pedagogy," and "analysis" reflect the critically oriented perspectives used to explore TEs' roles in teacher education. The terms "diversity" and "social justice" capture the core of the documents clustered under this topic. Based on these insights, we have titled this topic "Diversity and social justice." This title summarizes the collective focus of the studies, emphasizing the exploration of diversity and social justice as a central research theme.

4.1.3. Topic 3: collaboration and community engagement

The third topic included 71 publications, representing 9.42% of the entire dataset. These studies often explore various forms of collaboration

Table 4

TE research themes and topic-word distributions.

Topic 1	Field-specific knowledge and pedagogy											
Keywords	knowledge	teaching	teacher-educator	teacher	teacher-education	science	mathematics	education	pedagogical	belief		
Weight	57.00	49.00	46.00	40.00	40.00	37.00	25.00	20.00	20.00	18.00		
Number of articles (N = 754)						13.79						
104												
Topic 2	Diversity and social justice											
Keywords	teacher-education	education	pedagogy	diversity	critical	analysis	social-justice	multicultural	teaching	educational		
Weight	48.00	39.00	20.00	20.00	19.00	18.00	15.00	14.00	14.00	13.00		
Number of articles (N = 754)						11.27						
85												
Topic 3	Collaboration and community engagement											
Keywords	theory	teacher-educator	teacher-education	community	collaboration	practice	experience	mentor	professional-learning	career		
Weight	44.00	39.00	31.00	21.00	15.00	14.00	13.00	12.00	12.00	11.00		
Number of articles (N = 754)						9.42						
71												
Topic 4	Identity											
Keywords	teacher-educator	critical	education	identity	reflection	narrative	pedagogy	self-study	identity	method		
Weight	27.00	19.00	18.00	18.00	16.00	16.00	15.00	14.00	13.00	10.00		
Number of articles (N = 754)						8.75						
66												
Topic 5	Professional growth											
Keywords	learning	education	teacher-education	collaborative	teaching	community	online	professional-development-teacher-educator	practice	student		
Weight	65.00	22.00	22.00	16.00	16.00	15.00	13.00	10.00	9.00	8.00		
Number of articles (N = 754)						7.69						
58												
Topic 6	Educational policy and reform											
Keywords	research	teacher-education	education	policy	teacher-educator	educational	reform	academic	action	qualitative		
Weight	46.00	33.00	25.00	25.00	25.00	17.00	16.00	13.00	10.00	8.00		
Number of articles (N = 754)						7.69						
58												
Topic 7	Practice in teacher education											
Keywords	practice	teacher-education-teacher-educator	teaching	teacher	reflective	model	teach	professional	learn	inquiry		
Weight	33.00	16.00	15.00	13.00	13.00	12.00	11.00	10.00	9.00	8.00		
Number of articles (N = 754)						6.50						
49												
Topic 8	Quality standards											
Keywords	teacher	preparation	training	professional-development	teacher-education	teacher-educator	quality	standard	teach	EFL		
Weight	62.00	17.00	11.00	11.00	10.00	10.00	9.00	6.00	6.00	6.00		
Number of articles (N = 754)						6.23						
47												
Topic 9	English language education											
Keywords	language	English	instruction	strategy	awareness	classroom	teaching	training	learner	teacher-education		
Weight	38.00	20.00	8.00	7.00	6.00	6.00	6.00	6.00	5.00	5.00		
Number of articles (N = 754)						3.58						
27												
Topic 10	Technology competency and integration											
Keywords	technology	teacher-educator	integration	digital	literacy	ICT	Competence	instructional	professional-development-teacher-education	design		
Weight	26.00	12.00	10.00	10.00	10.00	10.00	8.00	6.00	4.00	4.00		
Number of articles (N = 754)						3.45						
26												

among TEs, whether with peers within educational institutions (Brody & Hadar, 2011), school mentors (Douglas, 2017), or through interdisciplinary cooperation with professionals from different departments (Heldens et al., 2015). There is also a recurrent theme of building and sustaining communities of practice, which manifest as formal partnerships with educational faculties or school communities (White et al.,

2022), and at times as more informal, practice-based communities within specific work contexts (Guillen & Zeichner, 2018). The essence of the relationships fostered through these collaborative and community endeavors is examined in terms of how these interactions shape the practices and professional growth of TEs.

A strong resonance has been observed between the key terms

assigned to this topic and the key aspects noted above. The terms "teacher educator," "teacher education," "community," "collaboration," "practice," "mentor," "professional learning," and "career" effectively capture the focal points of the studies under this topic. Synthesizing the essence of the key aspects and their interplay with the assigned terms, we named this topic "Collaboration and community engagement."

4.1.4. Topic 4: identity

The fourth research topic comprised 66 publications, accounting for 8.74% of the dataset. A key aspect of these studies is their focus on the adaptive endeavors of novice or transitioning TEs, grappling with the intricacies of assimilating new professional identities (Saito, 2013). Works such as the one by Butler et al. (2014) also address the complexities of fostering TE identities while mentoring diverse groups of teachers, both in-service and pre-service. Additionally, the research corpus delves into the trajectories of TEs striving to embody critical pedagogical stances as expressions of particular identities, as seen in Maistry's (2021) autoethnographic study.

The key terms "teacher-educator," "identity," "narrative," "critical," "pedagogy," and "self-study" closely align with the main theme of the publications clustered under this topic, which explores the evolution and embodiment of TE identity within diverse pedagogical, institutional, and cultural contexts. The terms "narrative" and "self-study" reflect two common methodological approaches employed in identity studies. Considering these insights, we have labeled this topic as "Identity" to denote the essence of the studies clustered under this topic.

4.1.5. Topic 5: professional growth

The fifth topic represented 7.69% of our dataset, encompassing 58 publications. It foregrounds the dynamic processes through which TEs develop professionally, such as engaging in reflective practices (Jove, 2011), adopting new pedagogical designs (Creely & Lyons, 2022), and making adjustments to their practices in response to changing conditions and demands (Cronin, 2022). Furthermore, this professional development is depicted as collaborative, frequently taking place within a communal context as seen in Botha and Nel (2022) or through shared experiences as described by Williams and Berry (2016).

The key terms assigned to this topic reflect the prominent research aspects mentioned above. "Professional-development-teacher-educator" is central to this theme, with the research conceptualizing TEs' professional development in terms of their "learning," which has consequently received the highest weighting. "Collaborative" and "community" emphasize the cooperative aspect of this learning. To encapsulate the key terms and research aspects, we have labeled it as "Professional growth." The term "growth" was chosen to offer a more comprehensive representation that includes both "learning" and "development."

4.1.6. Topic 6: educational policy and reform

The sixth research theme encompassed 58 publications, accounting for 7.69% of the dataset. One aspect emphasized by these studies is TEs' roles as developers of educational policies. Aydarova et al. (2021) explore this aspect by examining TEs' active involvement in policy development. Additionally, TEs serve as implementers or mediators of policy and reform, with studies addressing their interpretation (Lambert & Penney, 2020), negotiation (Aldous et al., 2022), and enactment (Grossman et al., 2007), typically within a national context. The literature also examines the connection between specific policies and TEs' work. Kyaw's (2022) research investigates the influence of policies on TEs' research engagement, while Snoek et al. (2011) analyze EU policy documents regarding the development of TE quality.

The key terms associated with this theme reflect the main research aspects. "Policy" and "reform" denote the scope of TEs' engagement, marking the areas where they exert influence and are influenced. The studies focus on the "research" and "action" undertaken by TEs in relation to educational policies and reforms, hence these two terms are linked to the theme, with "research" receiving the most emphasis.

Drawing from these observations, we titled this theme "Educational policy and reform."

4.1.7. Topic 7: practice in teacher education

The seventh research theme included 49 documents, accounting for 6.50% of the dataset. This collection explores the varied practices of TEs across different settings, formats, and modalities. It examines the environments in which these practices unfold, from university settings (White, 2011) to in-field experiences (Brown & Samuel, 2022), highlighting the multitude of formats and pedagogical approaches TEs adopt, such as case-based methods (Ulvik et al., 2022) and interactive simulations (Schutz & Danielson, 2019). Additionally, the studies illuminate the modalities of TEs' practices, with instances like Amalia et al. (2020) discussing reflective lesson planning practices, White (2011) exploring the impact of explicit modeling, and Yoon et al. (2013) focusing on inquiry-based teaching methods.

Key terms such as "practice" and "teacher-education-teacher-educator" are at the forefront of this theme, directly linked to the practices performed by TEs in teacher education. Terms like "reflective," "model," and "inquiry" further emphasize the specific approaches and modalities that define TEs' practices. Taking into account the research aspects and key terms, we have titled this theme "Practice in teacher education."

4.1.8. Topic 8: quality standards

The eighth topic included 47 publications, representing 6.23% of the dataset. This body of research typically adopts an evaluative (Estaji & Kiani, 2022) and visionary approach (Singh et al., 2021). The studies offer diverse perspectives on a broad range of features, qualities, and standards, from those detailed in policy documents (Estaji & Kiani, 2022) to personal traits such as leadership (Shurr et al., 2022). Insights from TEs explore topics like teacher competencies and qualities (Singh et al., 2021), features of specific programs (Ferm Thorgersen et al., 2016), and the effectiveness of particular practices such as lesson study (Shinghachanh, 2019).

The terms "teacher-educator," "preparation," "training," and "professional-development" identify the primary agents and the spheres of their engagement. "Quality" and "standard" denote the benchmarks and objectives related to the evaluative and visionary focus observed within the studies, which cover areas such as teacher preparation, training, and professional development. Given these key aspects and the terms assigned, the topic has been named "Quality standards."

4.1.9. Topic 9: English language education

The ninth topic included 27 publications, representing 3.58% of our dataset, focusing on the varied roles of TEs in training future teachers, particularly in English language teaching and its use as an instructional medium across various subjects. The research emphasizes TEs' critical roles in preparing prospective teachers for multilingual and culturally diverse classrooms, illustrated by Flockton and Cunningham (2021), who explore how student teachers are equipped to engage with students from diverse linguistic backgrounds. Additionally, significant attention is directed towards developing effective pedagogical strategies for English language teaching, with Spiteri (2010) and Fogal (2017) discussing communicative and concept-based methods tailored to diverse educational settings.

These key aspects are captured in terms assigned to this topic such as "language," "English," "instruction," "strategy," "teaching," and "awareness," highlighting TEs' involvement and responsibilities in various aspects of English language teaching and its use as an instructional medium. Accordingly, we have named this topic "English Language Education" to reflect the extensive focus on English language for broader educational purposes.

4.1.10. Topic 10: technology competency and integration

The final topic included 26 publications, accounting for 3.45% of the

dataset. These studies highlight the need for TEs to develop digital competencies that extend beyond mere technical skills, emphasizing a critical understanding of how technology can enhance teaching and learning (McVee et al., 2008). They also focus on the ability of TEs to integrate technology into their practices (Ngao et al., 2022).

Additionally, professional development is a recurrent theme, with Gondwe (2021) emphasizing the importance of ongoing training and support for TEs to keep abreast of technological advancements and effectively integrate these tools into their pedagogical approaches.

The key terms "technology," "digital," "integration," and

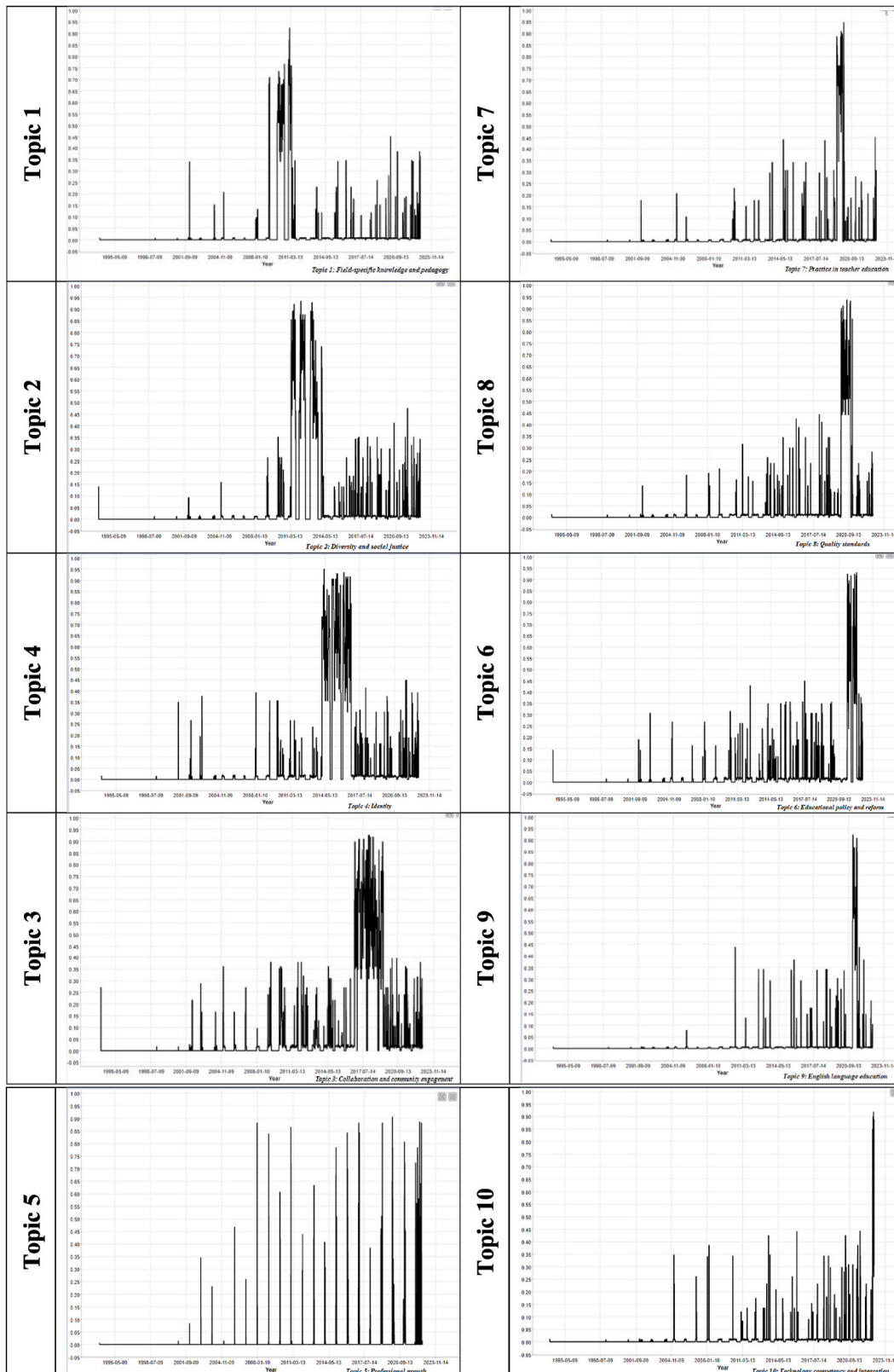


Fig. 4. Time series analyses of research topics.

"competence" capture the main areas of focus within this topic. "Technology" and "digital" relate to the tools and platforms used, "integration" describes the application of these tools in practices, and "competence" relates to TEs' proficiency with technology. Thus, the topic has been named "Technology competency and integration," encapsulating the dual emphasis on TEs' technological skill set and the incorporation of these skills into their practices.

4.2. Trends in research themes: time series analyses

TSA of the research themes is presented in Fig. 4, with each theme individually displayed. We observe that certain research themes have experienced heightened attention during specific periods, distinguishing them from others. Some topics show trends lasting only one year (e.g., Topics 7 and 9), while others span up to three years (e.g., Topics 2, 3, and 4). Though interest in the topics continues beyond these periods, there is a noticeable decline in research interest scores. An exception is Topic 5 (professional growth), which consistently maintains high research interest without following a periodic trend.

The trends identified until the 2020s are noteworthy. Notably, the prominent topics until the 2020s were field-specific knowledge/pedagogy (Topic 1) from 2009 to 2012, diversity and social justice (Topic 2) from 2011 to 2014, identity (Topic 4) from 2014 to 2017, and collaboration/community engagement (Topic 3) from 2016 to 2019. Starting in 2019, short-term trends emerged in practice (Topic 7), quality standards (Topic 8), English language education (Topic 9), and technology (Topic 10). As of 2022, professional growth (Topic 5) and technology (Topic 10) are the themes showing rising trends.

TSA offers valuable insights into the evolution of TE research. Significant research interest in TEs began emerging in the 2000s. Early studies focused on collaboration/community engagement (Topic 3), identity (Topic 4), and professional growth (Topic 5), forming the foundation of TE research. As the field matured, it expanded to include field-specific pedagogy/knowledge (Topic 1) and diversity and social justice (Topic 2). While topics such as technology (Topic 10), educational policies and reforms (Topic 6), quality standards (Topic 8), practice (Topic 7), and English language education surfaced sporadically in early TE research, they only became prominent after the 2010s, now representing key areas of focus within the field.

5. Discussion and conclusion

In this section, we discuss the findings from our LDA-based topic modeling analysis on TE research themes. We also focus on TSA to share observations regarding the trends and developments of these themes over time.

5.1. Research themes in TE studies

Our LDA-based topic modeling analysis pinpointed 10 distinct research themes, each marking a significant focus area within the dataset. These themes can be grouped into three categories based on their alignment with existing review studies and special issue calls: two themes (topics 4 and 5) are well-recognized within the scholarly community; five themes (topics 1, 2, 3, 7, and 10) were previously implied but are now explicitly defined; and three themes (topics 6, 8, and 9) represent newly designated areas identified by our findings and that have not been extensively addressed before. This section will discuss each group and delve into the specific themes within each group, highlighting their relevance to existing literature.

Within this framework, Topic 4 (identity), is both well-established and extensively explored. Its significance is evidenced by systematic reviews and special issues calls focused on this area. For instance, Izadinia's (2014) comprehensive review centers on TE identity, and the Journal of Mathematics featured a special issue (Montes, 2021) dedicated to this theme. Recurrent mentions of identity in various scholarly

reviews, including Yuan et al. (2022) on TESOL and Hinojosa-Paredes (2020) on professional agency, confirm its pivotal role in TE discourse. These reviews illustrate that identity not only stands as a critical theme on its own but also intersects with broader research on TEs.

Our analysis also brings to light an intriguing aspect regarding Topic 4: adaptational challenges, reported by various review studies, also surface as a key aspect of the research clustered under identity. Such challenges are discussed especially in the context of novice or transitioning TEs. In his review, Saito (2013) addresses these issues, focusing on themes such as fear of research and adjustment to new work environments. Similarly, Izadinia (2014) categorizes these challenges into adaptational and emotional aspects, while Ping et al. (2018) associate them with professional learning. Our insights contribute to the existing discourse by underscoring that these challenges are not only prevalent but also central to the research on TE identity.

Topic 5, professional growth, stands as a second well-recognized research theme, underscored by several special issues from journals such as JTE (Knight et al., 2014), IJSME (Krainer et al., 2021), and JM (Montes, 2021). These publications reflect the profound and collective interest in this area. Additionally, Ping et al. (2018) conducted a systematic review on this topic, affirming its status as a distinct research theme. Further highlighting its importance, Yuan et al. (2022) connected TEs' professional development in the TESOL field to their identity, while Phuong et al. (2018) explored various areas of professional development activities. Hinojosa-Paredes (2020) also emphasized professional development as a crucial factor influencing professional agency. The consistent focus on professional growth in special issue calls and review studies confirms its established status as a distinct research theme within the field.

We now turn to the second category of themes in our study: Topics 1, 2, 3, 7, and 10. While these topics are commonly recognized in the findings of various review studies, none had previously been the sole focus of a dedicated review. Thus, although they were previously implied across various studies, our analysis distinctly identifies them as independent research themes. Topic 1, within this category, focuses on field-specific knowledge and pedagogy. Two review studies adopting a field-specific perspective—McEvoy et al. (2015) in Physical Education and Yuan et al. (2022) in TESOL—highlight the significance of teaching/pedagogy and knowledge/expertise within their respective domains. These elements are also recognized by Ping et al. (2018) as key components of professional learning content, while Phuong et al. (2018) identify pedagogical skills as central to faculty development activities. Additionally, several field-specific education journals—particularly in mathematics education like JMTE (Beswick & Goos, 2018), MTED (Muir et al., 2018), and TME (Appova et al., 2020)—have issued calls and published content emphasizing mathematics TEs' knowledge and pedagogies. Thus, Topic 1 is strongly implied as a research theme by both reviews and journal calls.

Two other research themes highlighted in special issue calls are Topics 7 and 10. Topic 7 (practice) was featured as a special issue topic by JTE (Knight et al., 2014) and later by TME (Appova et al., 2020). Topic 10 (technology) was the subject of a JTTE call (Slykhuis et al., 2019). Both topics are frequently mentioned in review studies. For Topic 7, McEvoy et al. (2015) connected this to role expectations within physical education; Phuong et al. (2018) referred to it as instructional activities in faculty development; Ping et al. (2018) framed it as reflections within professional learning; and Yuan et al. (2022) conceptualized it in terms of professional engagement, teaching, and practicum supervision in TESOL. For Topic 10, Hangul et al. (2022) noted an increasing trend in TE technology integration, while Phuong et al. (2018) identified it as a prominent theme in faculty development activities. These reviews and special issue calls hence have clear indications for both topics as significant TE research themes.

Topics 2 and 3 have secured their presence within review studies, although they have not specifically been featured in special issue calls. Topic 2 (diversity and social justice) has seen a surge in research

interest, as identified by [Hangul et al. \(2022\)](#), and reinforced by [Hinojroza-Paredes \(2020\)](#) who noted social justice as a key influence on professional agency. Topic 3 (collaboration/community engagement) was highlighted in [Izadinia's \(2014\)](#) review, which linked collaboration to identity development and stressed the importance of supportive relationships within learning communities. Additionally, [McEvoy et al. \(2015\)](#) discussed its relevance in physical education, highlighting the interaction with various stakeholders such as teachers, schools, and communities. [Ping et al. \(2018\)](#) also recognized it as a prominent theme in professional learning activities. These acknowledgments in review studies demonstrate these two topics as important research foci within TE research.

Considering the third category, our findings identified three themes—Topics 6 (Policy and reform), 8 (Quality standards), and 9 (English language education)—as newly designated research areas that have not been extensively explored previously. Despite the absence of specific mentions in special issues or review studies, there is a significant body of research focused on these topics. Interestingly, these topics have emerged without the prior visibility typically provided by dedicated reviews or special issues, suggesting they may represent emerging interests in the field. The identification of these areas as independent research themes highlights the need for review studies to synthesize existing findings, draw connections with other topics, and underscore the importance and potential impact of these emerging areas.

5.2. Research trends in TE field

TSA provided important insights into the trends and evolution of the field's scientific growth. Firstly, research interest in the field began emerging in the 2000s and has continued until the present day. Notable trends initially started to emerge from 2009 onwards, playing a leading role in shaping the field. These trending research topics include knowledge/pedagogy (Topic 1), diversity and social justice (Topic 2), collaboration (Topic 3), identity (Topic 4), and professional growth (Topic 5). Secondly, starting from 2019, short-term trends have been observed across various topics. These trends appear to have emerged closely and even in parallel with each other (see [Fig. 4](#) for Topics 7, 8, 9, and 10) during the period where [Hangul et al. \(2022\)](#) observed exponential growth. According to [Price and Tukey \(1963\)](#), during the exponential growth phase, a scientific field begins to mature, attracting the attention of a large number of researchers and leading to divergences and variations in research interests. Our TSA reflect these observations, demonstrating that research interest remains sustained and active across the identified topics, with noticeable divergencies in research interest that prompt the emergence of specific trends over shorter periods.

At this point, we would like to share three observations regarding the formation of the identified trends. Firstly, both general and field-specific education/teacher education journals appear to have significantly influenced specific research themes and contributed to the emergence of trends, particularly through special issue calls dedicated to TEs. As discussed in the previous section, there are notable similarities between the topics of these special issues and five specific research themes (topics 1, 4, 5, 7, 10) that we identified. Importantly, some of these special issues coincided with periods when the corresponding themes were gaining attention. For instance, MTED's special issue call ([Muir et al., 2018](#)) under Topic 7 (practice) was published in 2018 when the topic was trending, and JM's ([Montes, 2021](#)) in 2021 when the topic 5 (professional growth) was gaining attention. These observations suggest that special issues published by both general and field-specific education journals have discernibly shaped the research themes and contributed to the emergence of trends.

Our second observation concerns the influence of educational policies and reform initiatives from leading countries in TE research. According to [Hangul et al. \(2022\)](#), the USA, Australia, England, Canada, and the Netherlands are the top five countries in terms of publication output on TEs. These countries are central to ongoing debates on

multiculturalism, multilingualism, equality, and social justice in education, and they actively engage in related policy development and reforms. For instance, in the UK, significant policies include the Equality Act in 2010, the Prevent strategy in 2011, and the Teacher's Standards in 2012. Australia saw the Curriculum reform (see [Ditchburn, 2012](#)) and the National Safe Schools Framework both in 2010. Canada, known for its cultural diversity, has implemented provincial initiatives like British Columbia's Cultural Diversity and Relational Competency Framework and Ontario's Intercultural Education (for an overview, see [Akkari & Radhouane, 2022](#)). In the United States, Every Student Succeeds Act implemented in 2015 and aimed at ensuring equal educational opportunities and reducing discrimination. These policies and frameworks, directly or indirectly, address teacher training and the broader educational context. Post-2010s, research themes such as diversity and social justice (topic 2), and policies/reforms (topic 6) have gained significant attention, fueled by these reforms. Additionally, English language education (topic 9) has been influenced by the multicultural and multilingual settings these policies foster. Thus, these topics have not only become prominent research themes but also trends shaped by educational policies and reforms in the leading countries in TE research.

Our third observation concerns the trending topics of the 2020s, which include technology competency/integration (topic 10), professional growth (topic 5), policy and reform (topic 6), and quality standards (topic 8). A key factor, we feel, for the surge in research interest in these areas is likely the global impact of the Covid-19 pandemic, which necessitated emergency remote teaching worldwide. This shift spurred increased interest in technology competencies and TEs' skills, with researchers like [Salinas and Garrido \(2022\)](#) and [Donitsa-Schmidt and Ramot \(2022\)](#) highlighting challenges in adaptation and usage. The pandemic also prompted studies on professional development needs specific to these demanding conditions ([Sunggingwati et al., 2022](#)) and evaluations of teacher qualifications acquired via remote teaching ([Darling-Hammond & Hylar, 2020](#)), as well as reviews of relevant policies ([Ramot & Donitsa-Schmidt, 2021](#)). Therefore, the emergence of these four topics as trends during and post-pandemic could be viewed in relation to the transformative impact of pandemic on educational practices.

6. Limitations, implications, and future research suggestions

In this topic modeling study, we differentiated research themes and elaborated on their trends in the TE field. We observed that two themes—identity and professional growth—have been the subject of dedicated systematic reviews, providing in-depth insights into the research conducted under these topics. Recognizing the value of such reviews, we encourage similar efforts for the remaining eight research themes. These reviews would enable a more detailed exploration and understanding of the TE research area.

It is crucial to acknowledge the limitations of our study, which exclusively employed data sourced from Scopus and focused solely on English language publications. These choices may have led to exclusion of some pertinent studies, potentially introducing bias. This limitation suggests that extending our analysis to include multiple databases and diverse languages could provide a more inclusive understanding of the research topics in the field.

Our study employed a targeted search strategy, utilizing the term "teacher educator*" exclusively in article titles. This approach was adopted to enhance precision and relevance, ensuring that our dataset focused primarily on studies where TEs are the central subject. While this has helped to maintain a clear thematic focus by excluding incidental mentions of TEs, it may have inadvertently omitted some relevant studies. We acknowledge this as a limitation of our current research approach. To address this limitation, we recommend that future studies consider employing a broader search strategy to construct a more comprehensive dataset.

Another limitation is the inherent subjectivity in naming identified

topics, a common challenge in inferential content analyses (Gurcan et al., 2021). To mitigate this, our study employed a systematic three-stage labeling process, detailed in the Method section. Following recommendations from researchers like Maier et al. (2018), we carefully crafted our labels to encapsulate key aspects and assigned terms from the studies. Additionally, during the validation process, we aligned our topic labels with scholarly discourse, significantly informed by insights from review studies and special issue calls. Yet, further studies evaluating the robustness of our identified topic labels would be beneficial.

Determining the optimal number of topics in topic modeling studies is a common challenge. The number of topics in our study was guided by Perplexity analysis, which effectively helps to limit the number of topics but does not provide a definitive count (Blei et al., 2003). This is because topic modeling assumes that documents contain multiple topics, each represented with varying probabilities. We focused on documents with high posterior probabilities to pinpoint core topics. However, the spectrum of topics could be expanded by including the documents with lower probabilities. We recommend that future studies explore different numbers of topics through content analyses to broaden the thematic scope of TE research.

Addressing limitations regarding the validity of labels and the number of topics, researchers emphasize the importance of conducting multiple field studies using the same dataset and parameters to provide empirical evidence of robustness (DiMaggio et al., 2013; Levy & Franklin, 2014). To enable replicability, we have shared our dataset, publications assigned to topics, KNIME workflows, and customized algorithms in a data repository. This allows future researchers to verify our findings, and we strongly encourage such efforts to deepen understanding of the field.

We conclude our study by sharing two important implications. TSA revealed that the ten research themes continue to garner significant attention from TE researchers. While individual themes provide valuable insights into specific aspects of TEs, exploring the connections and intersections between them could reveal more nuanced patterns and complexities. For instance, understanding how policy engagement intersects with quality standards or how technology competencies relate to professional growth can provide a more holistic view of the challenges and opportunities faced by TEs. Exploring these interconnections could enhance our understanding of TEs as a crucial occupational group and we recommend pursuing such research in future studies.

TSA also suggested that Topics 1–5, characterized by high research interest scores, have been extensively explored and thus could be considered relatively more mature and saturated research areas. These topics have attracted significant research attention, indicating a substantial body of existing literature and a solid foundation of knowledge. In contrast, Topics 6–10 display lower research interest scores, suggesting they are relatively less explored and offer more opportunities for further development. Exploring and delving deeper into these less matured topics seems to be more prone to the new discoveries and the further advancement of the field.

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Ethical permission

This study draws on published research extracted from Scopus database on teacher educators, which were available based on Institutional subscription. Hence ethical permission for the conduct of this study was not applicable.

Availability of data, codes and materials

The data were extracted from Scopus database on account of

Institutional subscription. The dataset, LDA analyses and KNIME workflow/algorithms are shared in a public repository and available to the interested parties through the following link: <https://doi.org/10.17605/OSF.IO/CN7Q8>.

CRedit authorship contribution statement

Mehmet Fatih Özmantar: Conceptualization, Data curation, Methodology, Writing – original draft. **Kenan Gökdağ:** Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing. **Tuğba Hangül:** Data curation, Methodology, Validation, Writing – review & editing. **Gülay Agaç:** Data curation, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors have no competing interests to declare.

Data availability

I have shared the link to attach data/code/algorithms as a supplementary file during Attach File step.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.tate.2024.104696>.

References

- Akkari, A., & Radhouane, M. (2022). Multicultural education in the United States. In A. Akkari, & M. Radhouane (Eds.), *Intercultural approaches to education: From theory to practice* (pp. 65–78). Springer International Publishing. https://doi.org/10.1007/978-3-030-70825-2_5.
- Aldous, D., Evans, V., & Penney, D. (2022). Curriculum reform in Wales: Physical education teacher educators' negotiation of policy positions. *Curriculum Journal*, 33(3), 495–514. <https://doi.org/10.1002/curj.149>
- Amalia, L. L., Widiati, U., Basthomi, Y., & Cahyono, B. Y. (2020). Reflective practice on lesson planning among EFL teacher educators. *Indonesian Journal of Applied Linguistics*, 10(1), 153–160. <https://doi.org/10.17509/IJAL.V10I1.25025>
- Appova, A., Welder, R. M., & Feldman, Z. (2020). Guest editorial: Special issue on supporting mathematics teacher educators' knowledge and practices for teaching content to prospective (Grades K-8) teachers. *Mathematics Enthusiast*, 17(2–3), 337–366. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084818094&partnerID=40&md5=a86e40025154f6bc631fd119cd439a83>.
- Asmussen, C. B., & Möller, C. (2019). Smart literature review: A practical topic modelling approach to exploratory literature review. *Journal of Big Data*, 6(1), 93. <https://doi.org/10.1186/s40537-019-0255-7>
- Aydarova, E., Rigney, J., & Dana, N. (2021). 'Small but mighty': A case study of teacher educators disrupting neoliberal reforms of teacher education and reclaiming a voice in policy conversations. *Journal of Education for Teaching*, 47(5), 732–744. <https://doi.org/10.1080/02607476.2021.1909418>
- Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, 1(1), 377–386. https://doi.org/10.1162/qss_a_00019
- Backman, E., Pearson, P., & Forrest, G. J. (2019). The value of movement content knowledge in the training of Australian PE teachers: Perceptions of teacher educators. *Curriculum Studies in Health and Physical Education*, 10(2), 187–203. <https://doi.org/10.1080/25742981.2019.1596749>
- Beswick, K., & Goos, M. (2018). Mathematics teacher educator knowledge: What do we know and where to from here? *Journal of Mathematics Teacher Education*, 21(5), 417–427. <https://doi.org/10.1007/s10857-018-9416-4> [Editorial].
- Blei, D. M. (2012). Probabilistic topic models. *Communications of the ACM*, 55(4), 77–84. <https://doi.org/10.1145/2133806.2133826>
- Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *Journal of Machine Learning Research*, 3(Jan), 993–1022.
- Botha, C., & Nel, C. (2022). Purposeful collaboration through professional learning communities: Teacher educators' challenges. *International Journal of Learning, Teaching and Educational Research*, 21(6), 210–225. <https://doi.org/10.26803/ijlter.21.6.13>
- Boyd, P., Harris, K., & Murray, J. (2007). *Becoming a teacher educator: Guidelines for the induction of newly appointed lecturers in initial teacher education* (pp. 1–28). ESCalate Education Subject Centre.
- Brant, C. A. R., & Willox, L. (2020). Queering teacher education: Teacher educators' self-efficacy in addressing LGBTQ issues. *Action in Teacher Education*, 1–16. <https://doi.org/10.1080/01626620.2020.1776176>

- Brody, D., & Hadar, L. (2011). "I speak prose and I now know it." Personal development trajectories among teacher educators in a professional development community. *Teaching and Teacher Education*, 27(8), 1223–1234. <https://doi.org/10.1016/j.tate.2011.07.002>
- Brown, L., & Coles, A. (2010). Mathematics teacher and mathematics teacher educator change-insight through theoretical perspectives. *Journal of Mathematics Teacher Education*, 13(5), 375–382. <https://doi.org/10.1007/s10857-010-9159-3>
- Brown, C. J. W., & Samuel, M. A. (2022). Sustaining evolving teaching practicum models in higher education: A conversational ethnodrama between South African teacher educators. *Perspectives in Education*, 40(3), 163–180. <https://doi.org/10.18820/2519593X/ptie.v40.i3.11>
- Bullough Jr, R. V. (2005). Being and becoming a mentor: School-based teacher educator and teacher educator identity. *Teaching and Teacher Education*, 21(2), 143–155. <https://doi.org/10.1016/j.tate.2004.12.002>
- Butler, B. M., Burns, E., Frierman, C., Hawthorne, K., Innes, A., & Parrott, J. A. (2014). The impact of a pedagogy of teacher education seminar on educator and future teacher educator identities. *Studying Teacher Education*, 10(3), 255–274. <https://doi.org/10.1080/17425964.2014.956716>
- Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of computers & education. *Computers & Education*, 151, Article 103855. <https://doi.org/10.1016/j.compedu.2020.103855>
- Chick, H., & Beswick, K. (2018). Teaching teachers to teach boris: A framework for mathematics teacher educator pedagogical content knowledge. *Journal of Mathematics Teacher Education*, 21(5), 475–499. <https://doi.org/10.1007/s10857-016-9362-y>
- Cochran-Smith, M. (2003). Learning and unlearning: The education of teacher educators. *Teaching and Teacher Education*, 19(1), 5–28. [https://doi.org/10.1016/S0742-051X\(02\)00091-4](https://doi.org/10.1016/S0742-051X(02)00091-4)
- Creely, E., & Lyons, D. (2022). Designing flipped learning in initial teacher education: The experiences of two teacher educators. *Australasian Journal of Educational Technology*, 38(4), 40–54. <https://doi.org/10.14742/ajet.7957>
- Cronin, S. (2022). Pandemic pedagogies, practices and future possibilities: Emerging professional adjustments to the working practices of university teacher educators. *Educational Review*, 74(3), 720–740. <https://doi.org/10.1080/00131911.2021.1978397>
- Czerniawski, G., Guberman, A., & MacPhail, A. (2017). The professional developmental needs of higher education-based teacher educators: An international comparative needs analysis. *European Journal of Teacher Education*, 40(1), 127–140. <https://doi.org/10.1080/02619768.2016.1246528>
- Darling-Hammond, L., & Hyler, M. E. (2020). Preparing educators for the time of COVID ... and beyond. *European Journal of Teacher Education*, 43(4), 457–465. <https://doi.org/10.1080/02619768.2020.1816961>
- Dengerink, J., Lunenberg, M., & Kools, Q. (2015). What and how teacher educators prefer to learn. *Journal of Education for Teaching*, 41(1), 78–96. <https://doi.org/10.1080/02607476.2014.992635>
- Dewi, A., & Thiel, K. (2017). Topic extraction: Optimizing the number of topics with the elbow method. *KNIME*, June 19. Available online: <https://www.knime.com/blog/topic-extraction-optimizing-the-number-of-topics-with-the-elbow-method>.
- DiMaggio, P., Nag, M., & Blei, D. (2013). Exploiting affinities between topic modeling and the sociological perspective on culture: Application to newspaper coverage of U. S. government arts funding. *Poetics*, 41(6), 570–606. <https://doi.org/10.1016/j.poetic.2013.08.004>
- Ditchburn, G. (2012). A national Australian curriculum: In whose interests? *Asia Pacific Journal of Education*, 32(3), 259–269. <https://doi.org/10.1080/02188791.2012.711243>
- Donitsa-Schmidt, S., & Ramot, R. (2022). COVID-19 – a boundary crossing event for teacher educators. *Journal of Education for Teaching*, 48(4), 407–423. <https://doi.org/10.1080/02607476.2022.2088267>
- Douglas, A. S. (2017). Extending the teacher educator role: Developing tools for working with school mentors. *Professional Development in Education*, 43(5), 841–859. <https://doi.org/10.1080/19415257.2016.1258655>
- Elgesem, D., Feinerer, I., & Steskal, L. (2016). Bloggers' responses to the snowden affair: Combining automated and manual methods in the analysis of news blogging. *Computer Supported Cooperative Work*, 25(2), 167–191. <https://doi.org/10.1007/s10606-016-9251-z>
- Estaji, M., & Kiani, S. (2022). Teacher educators' perceptions of teacher quality standards: Any congruence between local and global standards? *Ricerche di Pedagogia e Didattica*, 17(1), 1–22. <https://doi.org/10.6092/issn.1970-2221/13205>
- Ferm Thorgersen, C., Johansen, G., & Juntunen, M. L. (2016). Music teacher educators' visions of music teacher preparation in Finland, Norway and Sweden. *International Journal of Music Education*, 34(1), 49–63. <https://doi.org/10.1177/0255761415584300>
- Flockton, G., & Cunningham, C. (2021). Teacher educators' perspectives on preparing student teachers to work with pupils who speak languages beyond English. *Journal of Education for Teaching*, 47(2), 220–233. <https://doi.org/10.1080/02607476.2020.1855942>
- Fogal, G. (2017). Developing concept-based instruction, pedagogical content knowledge: Implications for teacher educators and L2 instructors. *Language and Sociocultural Theory*, 4(1), 53–75. <https://doi.org/10.1558/lst.29542>
- Gondwe, F. (2021). A case study on teacher educators' technology professional development based on student teachers' perspectives in Malawi. *Journal of Interactive Media in Education*, 2021(1). <https://doi.org/10.5334/jime.613>. Article 3.
- González, N., Moll, L. C., & Amanti, C. (Eds.). (2006). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Routledge.
- Griffiths, V., Thompson, S., & Hryniewicz, L. (2010). Developing a research profile: Mentoring and support for teacher educators. *Professional Development in Education*, 36(1–2), 245–262. <https://doi.org/10.1080/19415250903457166>
- Grimmer, J., & Stewart, B. M. (2013). Text as data: The promise and pitfalls of automatic content analysis methods for political texts. *Political Analysis*, 21(3), 267–297. <https://doi.org/10.1093/pan/mps028>
- Grossman, G. M., Onkol, P. E., & Sands, M. (2007). Curriculum reform in Turkish teacher education: Attitudes of teacher educators towards change in an EU candidate nation. *International Journal of Educational Development*, 27(2), 138–150. <https://doi.org/10.1016/j.ijedudev.2006.07.005>
- Guillen, L., & Zeichner, K. (2018). A university-community partnership in teacher education from the perspectives of community-based teacher educators. *Journal of Teacher Education*, 69(2), 140–153. <https://doi.org/10.1177/0022487117751133>
- Gurcan, F., Ozyurt, O., & Cagıtay, N. E. (2021). Investigation of emerging trends in the e-learning field using latent dirichlet allocation. *International Review of Research in Open and Distance Learning*, 22(2), 1–18. <https://doi.org/10.19173/irrodl.v22i2.5358>
- Güven, Z. A., Diri, B., & Çakaloğlu, T. (2019). Emotion detection with n-stage latent dirichlet allocation for Turkish tweets. *Academic Platform-Journal of Engineering and Science*, 7(3), 467–472. <https://doi.org/10.21541/apjes.459447>
- Hangul, T., Özmentar, M. F., & Agac, G. (2022). Teacher educators: A bibliometric mapping of an emerging research area [journal article]. *Australian Journal of Teacher Education (Online)*, 47(10), 39–58. <https://doi.org/10.14221/ajte.2022v47n10.3>
- Harzing, A.-W., & Alakangas, S. (2016). Google scholar, Scopus and the Web of science: A longitudinal and cross-disciplinary comparison. *Scientometrics*, 106(2), 787–804. <https://doi.org/10.1007/s11192-015-1798-9>
- Heldens, H., Bakx, A., & den Brok, P. (2015). Teacher educators' collaboration in subject departments: Collaborative activities and social relations. *Educational Research and Evaluation*, 21(7–8), 515–536. <https://doi.org/10.1080/13803611.2016.1153488>
- Hinojosa-Paredes, Y. (2020). Critical discourse analysis of university teacher educators' professionalism in Chilean Teacher Education Policy. *Education Policy Analysis Archives*, 28. <https://doi.org/10.14507/epaa.28.5201>
- Inglis, M., & Foster, C. (2018). Five decades of mathematics education research. *Journal for Research in Mathematics Education* *JRME*, 49(4), 462–500. <https://doi.org/10.5951/jresmetheduc.49.4.0462>
- Izadinia, M. (2014). Teacher educators' identity: A review of literature. *European Journal of Teacher Education*, 37(4), 426–441. <https://doi.org/10.1080/02619768.2014.947025>
- Jacobi, C., van Atteveldt, W., & Welbers, K. (2016). Quantitative analysis of large amounts of journalistic texts using topic modelling. *Digital Journalism*, 4(1), 89–106. <https://doi.org/10.1080/21670811.2015.1093271>
- Jacobi, C., Van Atteveldt, W., & Welbers, K. (2018). Quantitative analysis of large amounts of journalistic texts using topic modelling. In *Rethinking research methods in an age of digital journalism* (pp. 89–106). Routledge.
- Jove, G. (2011). How do I improve what I am doing as a teacher, teacher educator and action-researcher through reflection? A learning walk from lleida to winchester and back again. *Educational Action Research*, 19(3), 261–278. <https://doi.org/10.1080/09650792.2011.600526>
- Knight, S. L., Lloyd, G. M., Arbaugh, F., Gamson, D., McDonald, S. P., & Nolan, J. (2014). Professional development and practices of teacher educators. *Journal of Teacher Education*, 65(4), 268–270. <https://doi.org/10.1177/0022487114542220>
- Krainer, K., Even, R., Park Rogers, M., & Berry, A. (2021). Research on learners and teachers of mathematics and science: Forerunners to a focus on teacher educator professional growth. *International Journal of Science and Mathematics Education*, 19. <https://doi.org/10.1007/s10763-021-10189-8>
- Krokfors, L., Kynälähti, H., Stenberg, K., Toom, A., Maaranen, K., Jyrhämä, R., Byman, R., & Kansanen, P. (2011). Investigating Finnish teacher educators' views on research-based teacher education. *Teaching Education*, 22(1), 1–13. <https://doi.org/10.1080/10476210.2010.542559>
- Kyaw, M. T. (2022). Policy for promoting teacher educators' research engagement in Myanmar. *Teaching and Teacher Education*, 113, Article 103680. <https://doi.org/10.1016/j.tate.2022.103680>
- Lambert, K., & Penney, D. (2020). Curriculum interpretation and policy enactment in health and physical education: Researching teacher educators as policy actors. *Sport, Education and Society*, 25(4), 378–394. <https://doi.org/10.1080/13573322.2019.1613636>
- Lanier, J. E., & Little, J. W. (1986). Research on teacher education. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 527–569). MacMillan Publishing.
- Levy, K. E. C., & Franklin, M. (2014). Driving regulation: Using topic models to examine political contention in the U.S. trucking industry. *Social Science Computer Review*, 32(2), 182–194. <https://doi.org/10.1177/0894439313506847>
- Livingston, K. (2014). Teacher educators: Hidden professionals? *European Journal of Education*, 49(2), 218–232. <https://doi.org/10.1111/ejed.12074>
- Lunn Brownlee, J., Rowan, L., Ryan, M., Walker, S., Bourke, T., & Churchward, P. (2019). Researching teacher educators' preparedness to teach to and about diversity: Investigating epistemic reflexivity as a new conceptual framework. *Asia-Pacific Journal of Teacher Education*, 47(3), 230–250. <https://doi.org/10.1080/1359866X.2018.1555794>
- Maier, D., Waldherr, A., Miltner, P., Wiedemann, G., Niekler, A., Keinert, A., Pfetsch, B., Heyer, G., Reber, U., Häußler, T., Schmid-Petri, H., & Adam, S. (2018). Applying LDA topic modeling in communication research: Toward a valid and reliable methodology. *Communication Methods and Measures*, 12(2–3), 93–118. <https://doi.org/10.1080/19312458.2018.1430754>
- Maier, D., Waldherr, A., Miltner, P., Wiedemann, G., Niekler, A., Keinert, A., Pfetsch, B., Heyer, G., Reber, U., Häußler, T., Schmid-Petri, H., & Adam, S. (2021). *Applying LDA*

- topic modeling in communication research: Toward a valid and reliable methodology.* Routledge.
- Maistry, S. M. (2021). Aligning with feminism: Critical autoethnographic reflections of a profeminist heterosexual male teacher educator. *Journal of Education*, (82), 5–27. <https://doi.org/10.17159/2520-9868/i82a01>
- McEvoy, E., MacPhail, A., & Heikinaro-Johansson, P. (2015). Physical education teacher educators: A 25-year scoping review of literature. *Teaching and Teacher Education*, 51, 162–181. <https://doi.org/10.1016/j.tate.2015.07.005>. submitted for publication.
- McVee, M. B., Bailey, N. M., & Shanahan, L. E. (2008). Teachers and teacher educators learning from new literacies and new technologies. *Teaching Education*, 19(3), 197–210. <https://doi.org/10.1080/10476210802250216>
- Menna, L., Dharamshi, P., & Kosnik, C. (2022). How teacher educators' lived experiences affect teaching for social justice1. *The Teacher Educator*, 57(4), 409–430. <https://doi.org/10.1080/08878730.2022.2079037>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7), Article e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of science and Scopus: A comparative analysis. *Scientometrics*, 106(1), 213–228. <https://doi.org/10.1007/s11192-015-1765-5>
- Montes, M. (2021). Call for papers: Mathematics teacher educators' knowledge, identity and professional development. In *Mathematics*. Special Issue. <https://www.mdpi.com/si/75131>. <https://www.researchgate.net/publication/348836101>.
- Mork, S. M., Henriksen, E. K., Haug, B. S., Jorde, D., & Frøyland, M. (2021). Defining knowledge domains for science teacher educators. *International Journal of Science Education*, 43(18), 3018–3034. <https://doi.org/10.1080/09500693.2021.2006819>
- Muir, T., Bragg, L. A., & Livy, S. (2018). Engagement and impact: A focus on mathematics teacher educators' studies into practice. *Mathematics Teacher Education and Development*, 20(3), 1–3.
- Murray, J. (2005). Re-addressing the priorities: New teacher educators and induction into higher education. *European Journal of Teacher Education*, 28(1), 67–85. <https://doi.org/10.1080/02619760500040108>
- Murray, J., & Male, T. (2005). Becoming a teacher educator: Evidence from the field. *Teaching and Teacher Education*, 21(2), 125–142. <https://doi.org/10.1016/j.tate.2004.12.006>
- Ngao, A. I., Sang, G., & Kihwele, J. E. (2022). Understanding teacher educators' perceptions and practices about ICT integration in teacher education program. *Education Sciences*, 12(8), 549. <https://doi.org/10.3390/educsci12080549>
- Ohito, E. O. (2019). Mapping women's knowledges of antiracist teaching in the United States: A feminist phenomenological study of three antiracist women teacher educators. *Teaching and Teacher Education*, 86, Article 102892. <https://doi.org/10.1016/j.tate.2019.102892>
- Pascual, M. I., Montes, M., & Contreras, L. C. (2021). The pedagogical knowledge deployed by a primary mathematics teacher educator in teaching geometry. *Mathematics*, 9(11). <https://doi.org/10.3390/math9111241>. Article 1241.
- Phuong, T. T., Cole, S. C., & Zarestky, J. (2018). A systematic literature review of faculty development for teacher educators. *Higher Education Research and Development*, 37(2), 373–389. <https://doi.org/10.1080/07294360.2017.1351423>
- Ping, C., Schellings, G., & Beijgaard, D. (2018). Teacher educators' professional learning: A literature review. *Teaching and Teacher Education*, 75, 93–104. <https://doi.org/10.1016/j.tate.2018.06.003>
- Price, D. J. S., & Tukey, J. W. (1963). *Little science, big science*. Columbia University Press.
- Ramot, R., & Donitsa-Schmidt, S. (2021). COVID-19: Education policy, autonomy and alternative teacher education in Israel. *Perspectives in Education*, 39(1). <https://doi.org/10.18820/2519593X/pe.v39.i1.23>
- Saito, E. (2013). When a practitioner becomes a university faculty member: A review of literature on the challenges faced by novice ex-practitioner teacher educators. *International Journal for Academic Development*, 18(2), 190–200. <https://doi.org/10.1080/1360144X.2012.692322>
- Salinas, D., & Garrido, C. G. (2022). Teacher educators' adaptability process when faced with remote teaching. *Teaching and Teacher Education*, 120, Article 103890. <https://doi.org/10.1016/j.tate.2022.103890>
- Salvador, K., & Kelly-Mchale, J. (2017). Music teacher educator perspectives on social justice. *Journal of Research in Music Education*, 65(1), 6–24. <https://doi.org/10.1177/0022429417690340>. submitted for publication.
- Schutz, K. M., & Danielson, K. A. (2019). (Re)shaping representations of practice inside rehearsals of interactive read alouds: The complex work of teacher educators. *Literacy Research and Instruction*, 58(4), 232–252. <https://doi.org/10.1080/19388071.2019.1638472>
- Shingphachanh, S. (2019). Exploring the impact of lesson study through the views of Lao mathematics teacher educators on the needs, learning and difficulties. *International Journal for Lesson and Learning Studies*, 8(2), 98–116. <https://doi.org/10.1108/IJLLS-06-2018-0040>
- Shurr, J., Bouck, E. C., & McCollow, M. (2022). Examining teacher and teacher educator perspectives of teacher leadership in extensive support needs. *Teacher Education and Special Education*, 45(2), 160–179. <https://doi.org/10.1177/08884064211001455>
- Singh, C. K. S., Mostafa, N. A., Mulyadi, D., Madzlan, N. A., Ong, E. T., Shukor, S. S., & Singh, T. S. M. (2021). Teacher educators' vision of an 'ideal' teacher. *Studies in English Language and Education*, 8(3), 1158–1176. <https://doi.org/10.24815/siele.v8i3.19355>
- Slykhuis, D. A., Foulger, T. S., Graziano, K. J., & Schmidt-Crawford, D. A. (2019). Special issue editorial—the teacher educator technology competencies: So what? Now what? *Journal of Technology and Teacher Education*, 27(4), 431–436.
- Snoek, M., Swennen, A., & Klink, M. (2011). The quality of teacher educators in the European policy debate: Actions and measures to improve the professionalism of teacher educators. *Professional Development in Education*, 37, 651–664. <https://doi.org/10.1080/19415257.2011.616095>
- Spiteri, D. (2010). Back to the classroom: Lessons learnt by a teacher educator. *Studying Teacher Education*, 6(2), 131–141. <https://doi.org/10.1080/17425964.2010.495890>
- Stillman, J., Ahmed, K. S., & Castaneda-Flores, E. (2019). On cocoons, consciousness, and courage: Preparing justice-oriented teacher educators through critical pedagogies. *The Educational Forum*, 83(4), 432–452. <https://doi.org/10.1080/00131725.2019.1630538>
- Sunggugwati, D., Sudarman, S., Hakim, A., & Haviuddin, H. (2022). Shared voices of Indonesian teacher-educators from virtual research-workshop-series: Reflections on Covid-19 pandemic driven professional development. *Qualitative Report*, 27(7), 1220–1238.
- Tack, H., Valcke, M., Rots, I., Struyven, K., & Vanderlinde, R. (2018). Uncovering a hidden professional agenda for teacher educators: A mixed method study on Flemish teacher educators and their professional development. *European Journal of Teacher Education*, 41(1), 86–104. <https://doi.org/10.1080/02619768.2017.1393514>
- Turney, P. D., & Pantel, P. (2010). From frequency to meaning: Vector space models of semantics. *Journal of Artificial Intelligence Research*, 37, 141–188. <https://doi.org/10.1613/jair.2934>
- Ulvik, M., Eide, H. M. K., Eide, L., Helleve, I., Jensen, V. S., Ludvigsen, K., Roness, D., & Torjussen, L. P. S. (2022). Teacher educators reflecting on case-based teaching—a collective self-study. *Professional Development in Education*, 48(4), 657–671. <https://doi.org/10.1080/19415257.2020.1712615>
- van Velzen, C., van der Klink, M., Swennen, A., & Yaffe, E. (2010). The induction and needs of beginning teacher educators. *Professional Development in Education*, 36(1–2), 61–75. <https://doi.org/10.1080/19415250903454817>
- Vera-Baceta, M.-A., Thelwall, M., & Kousha, K. (2019). Web of science and Scopus language coverage. *Scientometrics*, 121(3), 1803–1813. <https://doi.org/10.1007/s11192-019-03264-z>
- Villarreal Ordenes, F., & Silipo, R. (2021). Machine learning for marketing on the KNIME Hub: The development of a live repository for marketing applications. *Journal of Business Research*, 137, 393–410. <https://doi.org/10.1016/j.jbusres.2021.08.036>
- Wang, X., McCallum, A., & Wei, X. (2007). Topical n-grams: Phrase and topic discovery, with an application to information retrieval. In *Seventh IEEE international conference on data mining (ICDM 2007)* (pp. 697–702). IEEE.
- Weisinger, C., Widmann, M., & Tonini, D. (2022). *Codeless time series analysis with KNIME: A practical guide to implementing forecasting models for time series analysis applications*. Packt Publishing.
- White, E. (2011). Working towards explicit modelling: Experiences of a new teacher educator. *Professional Development in Education*, 37(4), 483–497. <https://doi.org/10.1080/19415257.2010.531628>
- White, S. (2019). Teacher educators for new times? Redefining an important occupational group. *Journal of Education for Teaching*, 45(2), 200–213. <https://doi.org/10.1080/02607476.2018.1548174>
- White, S., & Forgasz, R. (2017). Supporting mentoring and assessment in practicum settings: A new professional development approach for school-based teacher educators. In *A companion to research in teacher education* (pp. 283–297). https://doi.org/10.1007/978-981-10-4075-7_19
- White, E., Timmermans, M., & Dickerson, C. (2022). Learning from professional challenges identified by school and institute-based teacher educators within the context of school–university partnership. *European Journal of Teacher Education*, 45(2), 282–298. <https://doi.org/10.1080/02619768.2020.1803272>
- Williams, J., & Berry, A. (2016). Boundary crossing and the professional learning of teacher educators in new international contexts. *Studying Teacher Education*, 12(2), 135–151. <https://doi.org/10.1080/17425964.2016.1192031>
- Yoon, H. G., Kim, M., Kim, B. S., Joong, Y. J., & Park, Y. S. (2013). Pre-service teachers' views of inquiry teaching and their responses to teacher educators' feedback on teaching practice. *Eurasia Journal of Mathematics, Science and Technology Education*, 9(4), 347–359. <https://doi.org/10.12973/eurasia.2013.944a>
- Yuan, R., Lee, I., De Costa, P. I., Yang, M., & Liu, S. (2022). TESOL teacher educators in higher education: A review of studies from 2010 to 2020. *Language Teaching*, 55(4), 434–469. <https://doi.org/10.1017/S0261444822000209>
- Zeichner, K., Bowman, M., Guillen, L., & Napolitan, K. (2016). Engaging and working in solidarity with local communities in preparing the teachers of their children. *Journal of Teacher Education*, 67. <https://doi.org/10.1177/0022487116660623>
- Zhu, J., & Liu, W. (2020). A tale of two databases: The use of Web of science and Scopus in academic papers. *Scientometrics*, 123(1), 321–335. <https://doi.org/10.1007/s11192-020-03387-8>