Comparing the Research Landscapes of Two Educational Research Institutions in Asia: A Preliminary Analysis of Journal Submissions, Author Keywords, and ERIC Categories

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ABSTRACT

Background. Educational research landscapes are dynamic, influencing institutional strategies and collaboration opportunities. This study examined the research paper publishing patterns at the National Institute of Education (NIE), Singapore, and the National Taiwan Normal University (NTNU), aiming to discern shared and unique research interests.

Method. Using bibliometric techniques, we analyzed 3,403 bibliographic records downloaded from the Web of Science (WoS) Core Collection linked to the category 'Education/Educational Research'. Our multi-pronged approach involved: 1. Descriptive statistics of journal submissions (1987-2022); 2. Qualitative analysis of the top 10 shared keywords across all years; 3. Classification of 342 papers from 2020-2022 using Education Resources Information Center (ERIC) thesaurus.

Results. Both institutions have seen growth in research outputs, aligning with global trends. NIE displays greater publishing diversity, while NTNU has a concentrated approach to specific journals. Both institutions share an emphasis on the nexus of education and technology, yet possess distinct journal preferences suggesting collaboration opportunities and differing priorities. Although their keyword usage mirrors global educational themes, regional deviations such as the underemphasis on "Human Capital" and "Gender" are apparent. As per ERIC categories, both prioritize "Classroom Perspectives": NIE showcasing a more specialized approach and NTNU displaying varied interests.

Implications. Collectively, these findings underscore that while NIE and NTNU resonate with global research trends, they also carve unique research paths shaped by their specific socio-cultural and institutional contexts.

1. INTRODUCTION

In an increasingly globalized world, education transcends national boundaries. The value of understanding, learning, and comparing educational research practices between institutions is paramount, providing a means of strengthening each's unique areas of strength and fostering potential collaboration. Both Singapore and Taiwan have been pivotal in advancing the educational research domain, with notable contributions acknowledged by scholars such as Barrot (2023), Lopes (2017), and Tosun (2021). The National Taiwan

Normal University (NTNU) is a vibrant learning community that has long been recognized as one of Taiwan's elite institutions of higher education. NTNU was formerly an institute for teachers' education, as suggested in the title Normal, that later emerged as a comprehensive university; and The National Institute of Education (NIE), Singapore, is the national teacher education institute and an integral part of the nation's education system. Offering multidisciplinary undergraduate and graduate education programmers, the institute empowers students to analyses, tackle, and resolve challenges in various career pathways, both within and beyond the realm of education. NTNU and NIE are renowned educational research institutions in these two regions, and both have made substantial strides in knowledge creation and dissemination, yet, to our knowledge, no comparative study has hitherto been carried out to juxtapose their research landscapes.

This study aims to address this gap, and our objective is to provide a preliminary analysis of the research landscape at NTNU and NIE, focusing on the unique and shared characteristics of their educational research interests.

Bibliometric analysis has become an indispensable tool for examining academic research landscapes, offering insights into publishing trends, research foci, and collaborative patterns (Barrot, 2023; Sezgin et al., 2022; Tan et al., 2012). By transforming bibliographic information into discernable trends and patterns, this method provides invaluable insights into the nature and trajectory of research within and across institutions. Our study employs this tool to examine the research outputs of NIE and NTNU, particularly focusing on their educational research. The analysis is based on an examination of journal submissions, keyword usage, and paper theme classification using the Education Resources Information Center (ERIC) thesaurus.

The significance of this research is manifold. First, it offers a granular view of the publishing trends at NTNU and NIE, thus informing institutional policy and guiding individual researchers. Second, by highlighting areas of shared interest, the study may act as a springboard for future collaborative efforts between the two institutions. Third, the findings could be instrumental for funding bodies to direct resources effectively.

The rest of the paper is organized as follows: The next section presents a literature review, outlining relevant prior studies and delineating our research's novelty. This is followed by the methodology section, which explains the data collection and analysis procedures. Subsequently, the results section presents the findings, and the discussion section interprets these results in light of the research questions. The paper concludes with an overview of the key takeaways and potential avenues for future research.

While it is beyond the scope of this paper to conduct an exhaustive analysis of the educational research at NTNU and NIE, this preliminary study will provide a critical foundation for further investigations into the respective and shared strengths of these two premier institutions in the field of education.

2. LITERATURE REVIEW

Bibliometric analysis offers a lens into the academic landscape, useful for tracking research trends, gauging publication significance (Lopes et al., 2017; Tan et al., 2012), and spotting discipline shifts and research focal points (Donmus Kaya, 2022). It illuminates prevailing directions, dominant areas, and collaboration potential.

The purpose of this literature review is to investigate the prevailing findings in bibliometric analysis within the context of educational research to provide a foundation for our comparative study of academic paper submitted by researchers in NTNU and NIE.

2.1 Bibliometric Studies in Educational Research: Global Results

Several shifts in educational research have been noted. In his theoretical paper, (Cheng, 2007) identified three significant shifts in the focus of educational research in the Asia-Pacific region, including Singapore and Taiwan. The first, "Internal Effectiveness" (1980s-90s), centered on optimizing teaching and learning processes. The second, "Interface Effectiveness" (1990s), prioritized meeting stakeholder expectations and educational accountability. The third, "Future Effectiveness" (2000s), emphasized the globalization, localization, and individualization of educational practices.

Studies have demonstrated how bibliometric analysis provide a granular understanding of research trends. Huang et al. (2020) conducted a bibliometric analysis on 19,750 papers from leading education journals between 2000 and May 2018, and using keyword co-occurrence networks, he segmented education research from 2000 to 2017 into three stages: from 2000-2007, emphasis was on teacher education, teaching strategies, human capital, and higher education; between 2008-2014, the spotlight shifted to professional development, distance education, and identity aspects within higher education; the 2015-2017 period broadened to include topics like governmentality in higher education, mathematics, and classroom teaching improvements. Furthermore, they pinpointed five core research topics that were present throughout all three stages of education research: "Interactive learning environment and teaching/learning strategies" consistently emerged as a primary focus. The rest four core topics "Human capital", "Teacher education", "Higher education", and "Equity and social justice" evolved in their prominence, highlighting the dynamic landscape of educational research over the examined period.

Tosun (2021) conducted a bibliometric analysis on 50 years of educational research within the Web of Science (WoS) database, analyzing 93,699 articles across 116 journals. He identified evolving research themes over time in educational studies. From 1974 to 2000, the emphasis was on problem-solving, teacher education, and constructivism. The period from 2001 to 2005 saw a transition towards interactive learning and collaboration. Between 2006 and 2010, the focus shifted to higher education, e-learning, and teaching strategies. The subsequent five years, from 2011 to 2015, concentrated on collaborative and interactive learning techniques. The research from 2016 to 2018 primarily emphasized assessment, professional development, and higher education. Lastly, in 2019 and 2020, the primary attention was on higher education, teacher education, and motivation.

Keyword analysis, while seemingly simplistic, serves as a reliable method to understand the core focus of research endeavors. Huang et al. (2020) identified the top ten keywords in educational research in the past two decades as: "higher education", "interactive learning environment", "teaching/learning strategies", "teacher education", "pedagogical issue", "improving classroom teaching", "professional development", "human capital", "computer-mediated communication", and "media in education". Tosun (2021) also concluded that the most frequent keywords in the education research field over the last half century included "higher education", "teacher education", "professional development", "assessment", "education", "gender", "motivation", "science education", "education policy", "learning", "curriculum", "teaching/learning strategies", "collaborative learning", "pedagogy", and "secondary education".

Both studies underscored the sustained significance of teacher education, interactive learning, teaching/learning strategies, professional development and higher education in educational discourse. And both studies show that, by the mid-2010s, professional development and higher education come to the forefront in analyses, albeit with Tosun (2021) additionally highlighting motivation as a key theme by 2019-2020.

Bibliometric analysis studies have also shown journal submission patterns in the field. Sönmez (2020) conducted a bibliometric analysis of the WoS database on scientific articles related to Social Studies

education, and found out 228 papers covering 1975 to January 2020. The research highlighted a rising interest in Social Studies education, with roughly 84 articles published in the past five years, and with "Theory and Research in Social Education" emerging as a significant journal in this area (Sönmez, 2020). Tosun (2021) found notable surges in publications were identified in 1980, 2008, and 2019. And "Computers & Education" and "International Journal of Science Education" were highlighted as the leading journals in the field. Concurrently, Huang et al. (2020) delineated three pivotal stages in education research: stability with under 10,000 publications annually from 2000–2007, a rise to 15,000–20,000 publications between 2008–2014, and a remarkable surge post-2015, exceeding 30,000 publications annually.

In their exploration of collaboration patterns and the evolving characteristics of educational research, Sezgin et al. (2022) conducted a bibliometric analysis of educational research publications from 2011 to 2020, sourcing data from WoS categories such as "Education and Educational Research" and "Psychology, Educational", among others. Their findings underscored a surge in multi-authorship and a consistent rise in reference counts, and highlighted an evolution in educational research, pointing to its increasingly organized, internationalized nature, its reduced fragmentation, and its inherent interdisciplinary character.

By comparing the above global trends with the research outputs of NTNU and NIE, our study hopes to identify their alignment or divergence with these larger movements, thereby unveiling their unique strengths and future trajectories.

2.2. BIBLIOMETRIC STUDIES IN EDUCATIONAL RESEARCH: REGIONAL RESULTS

Despite the growing use of bibliometric analysis in understanding educational research trends, comparative studies between institutions, particularly NTNU and NIE, are limited. However, there are prior studies covering Singapore and Taiwan.

In a content analysis of learning sciences research in Asia Pacific countries, Tan et al. (2012) scrutinized 24 research papers from three selected journals, spanning 1997 to 2010. Their findings illuminated distinct contribution patterns based on authors' affiliated countries. Notably, Singapore emerged as one of the top three contributors, evidencing a surge in learning sciences activities post-2006. Conversely, by the study's end in 2010, Taiwan displayed an emergent interest in this field.

Nylander and Tan (2022) undertook a bibliometric analysis of 9,017 articles from 2000 to 2020 to compare educational research in Singapore and Sweden. Using topic modeling, they discerned that Singapore's research predominantly focuses on pedagogical practices such as sociocultural perspectives on teaching, pre-service training, and educational psychology tied to student achievement. Notably, compared to Sweden, Singapore's research approach is characterized as more centralized, practically-oriented, and quantitative, with a less critical stance.

Barrot (2023) evaluated the state of educational research in Southeast Asia (SEA) in relation to global trends. From a comprehensive analysis of 13,527 documents from Scopus, Singapore prominently emerged as the region's frontrunner, contributing to 26.31% of the total output. Despite its modest annual growth rate of 9.27%, Singapore's research was distinguished by its high citation count, robust performance metrics, and substantial international collaborations. Moreover, half of SEA's top 10 educational scholars are based in Singapore, underscoring its pivotal role in educational research.

In Tosun (2021)’s study, geographically, Taiwan emerged as a prolific contributor in recent years, emphasizing teaching/learning strategies, interactive learning environments, cooperative/collaborative learning, computer-mediated communication, improving classroom teaching, e-learning, mobile learning, pedagogical issues, media in education and applications in subject areas. Moreover, bibliometric studies

have also delved into the use of specific social network platforms, like Facebook, in the realm of educational research. Lopes (2017) applied this technique to identify key journals, authors, and seminal articles in the field. Notably, Lopes' findings highlighted authors from Taiwan and four other countries as pivotal contributors to the global conversation on leveraging Facebook in educational research.

2.3 Summary and Our Research Questions

In summary, our review underscores the value of bibliographic studies in interpreting educational research landscapes. Our study contributes to the literature by providing a comparative bibliometric analysis of NTNU and NIE, illuminating unique strengths, shared research interests, and potential for collaboration. As we delve into the research landscapes of NTNU and NIE, we bring new insights into their roles within the broader educational research ecosystem. As such, our research questions are:

1. How do the journal submission patterns of NIE and NTNU researchers compare, and how do these patterns align with global publication trends in educational research?
2. How do the journal submission patterns of NTNU and NIE researchers highlight their unique and shared research interests in the field of education?
3. How do the keyword usage trends in educational research publications differ between NIE and NTNU, and what do these trends reveal about the evolving research focuses and priorities of the two institutions over time?
4. How do the keyword usage patterns in educational research publications from NIE and NTNU align with or diverge from global research trends in the field?
5. How do NIE and NTNU's research outputs, as classified by ERIC categories, compare in terms of their unique research focuses and shared interests?

3. METHOD

3.1 Data Collection

We utilized the WoS database to collect bibliographic data of research papers authored by scholars from NTNU and NIE. Our decision to employ WoS as the primary data source was influenced by its distinct category titled "Education & Education Research". In contrast, databases like Scopus group educational research under the broader umbrella of social sciences. As of our last update on August 12, 2022, our dataset comprises 3,403 records.

Our search protocol in WoS began with its basic search interface, where we set the "Affiliation" filter to "National Taiwan Normal University". The preliminary search produced tens of thousands of records from the WoS Core Collection. To enhance the specificity of our search, we opted for the “Education Educational Research” filter from the “Web of Science Categories” facet. Additionally, our search encompassed all citation indexes and all years (Timespan = All years) and was constrained to the "article" document type, which WoS defines as original research either published in academic journals or presented at symposia and conferences. This refined approach yielded 1,489 records affiliated with NTNU. Replicating the process for "National Institute of Education (NIE) Singapore" generated an additional 1,913 records.

3.2 Data Analysis

Examining journal submission patterns is pivotal in bibliometric studies, providing a foundational step in understanding a domain's research landscape (Sezgin et al. 2022; Tosun, 2021). Keyword analysis, while

seemingly simplistic, serves as a reliable method and proxies to understand the core focus of research endeavors (Huang et al., 2020).

To analyze the educational research landscapes of NTNU and NIE, we employed a three-step approach. First, we reviewed journal submissions from both institutions spanning 1987 to 2022. Next, from this collection, we identified a substantial list of 6,903 unique keywords to capture the breadth of topics, and conducted a qualitative examination of the most common keywords. Lastly, to gain insight into recent research trajectories, we categorized 342 papers published between 2020 and 2022 using the 41 primary categories outlined by the ERIC thesaurus 41 main categories[1].

For efficiency of the classification, we first employed an automated content classification system previously used in our research[2]. This system proposed initial categorizations for each paper based on the author keywords and ERIC Thesaurus indices. Subsequently, both authors of this study independently reviewed the bibliographic details, abstracts, and related information of each article. After comparing their evaluations with the system's initial suggestions, the most appropriate category was then assigned. The interface of this process is depicted in the Appendix. The system also had the capability to compute the degree of discrepancy between the classification by the two authors and computed the Kappa value for inter-rater reliability. Discrepancies in categorization led to online discussions among categorizers for resolution. With a Kappa value of 0.65, our findings indicate moderate agreement, affirming the moderate consistency in categorization outcomes by our team (Landis & Koch, 1977).

4. RESULT

4.1 Journal Submissions Analysis

NTNU and NIE have submitted papers across 361 journals over the years. The journal with the highest number of submissions is the "Journal of Research in Education Sciences" (n=193). This is followed by "Computers & Education" (n=172) and the "Asia Pacific Journal of Education" (n=127).

4.1.1 Overall Submissions Descriptive Statistical Analysis

Figure 1's top plot displays the yearly count of unique journals for NIE (red squares) and NTNU (blue circles). The bottom plot charts each university's annual paper submissions, using the same color and shape cues. NIE researchers publish in approximately 37.6 unique journals per year (SD = 32.1, range = 1-90), showing greater diversity than NTNU researchers, who average 20.9 unique journals (SD = 19.8, range = 1-63). In terms of paper submissions, NIE's average is 59.8 papers per year (SD = 53.6, range = 1-155), while NTNU's average is 46.5 (SD = 47.1, range = 1-154). These data suggests a higher degree of publishing diversity and volume from NIE researchers compared to their NTNU counterparts.

It shows that both NIE and NTNU exhibit increasing trends in unique journal publications and paper submissions. NIE saw a surge from 2008 to 2014, then stabilized, while NTNU grew gradually, with acceleration from 2010 to 2021.

[1] ERIC Thesaurus, https://eric.ed.gov/?ti=all

[2] Hao-ren Ke, Shun-hong Sie(2019). Exploring the Research Trends of Library and Information Science, 2006-2015.Journal of Library and Information Science 45(1):65-96 (April, 2019)

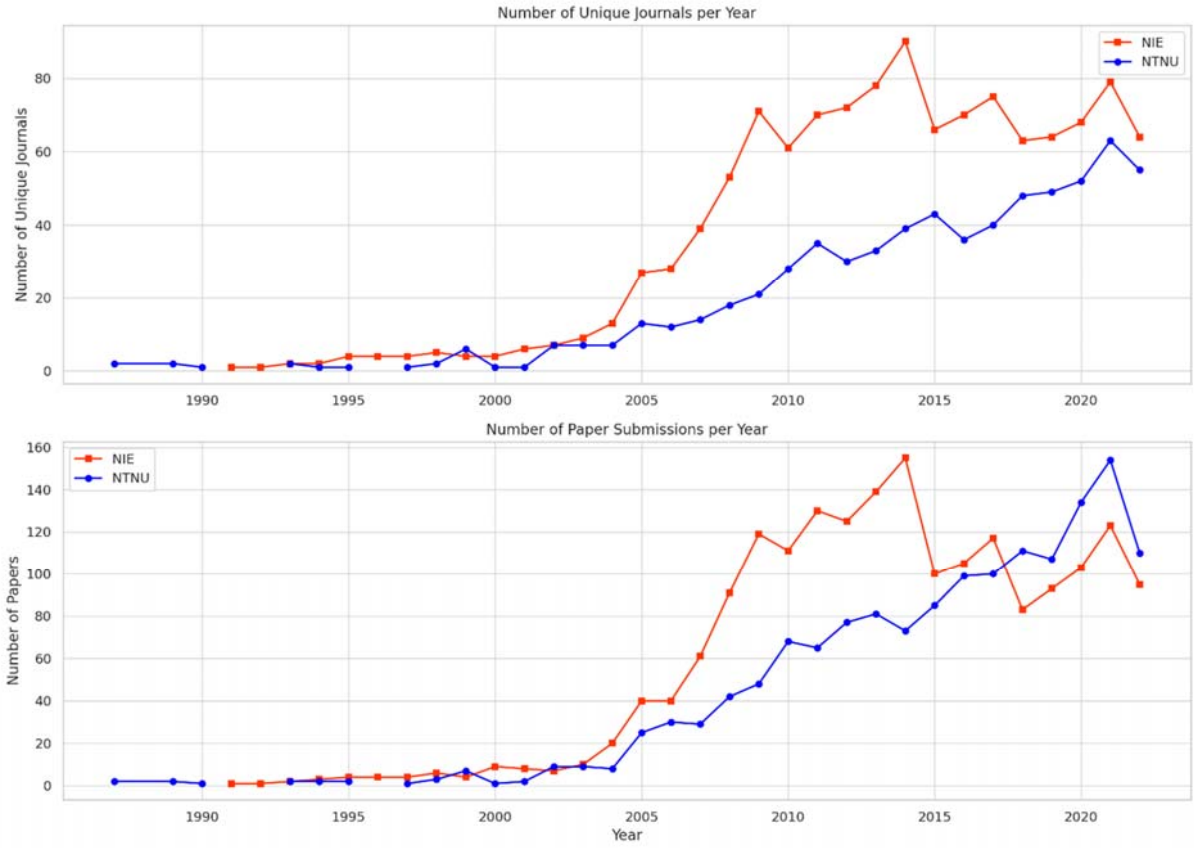


Figure 1. Number of unique journals and number of paper submissions over time by NIE and NTNU

Figure 2 plots the annual average papers per unique journal for NIE (red squares) and NTNU (blue circles). Both universities show fluctuations in average papers per unique journal, more pronounced for NTNU. NIE averages 1.43 papers (SD = 0.32, range = 1-2.25) and NTNU averages 1.86 (SD = 0.59, range = 1-2.75). These data show that NTNU researchers tend to submit more papers per unique journal compared to NIE researchers.

For NIE, the average number of papers per unique journal increased sharply around 2004 and then seemed to stabilize at a higher level compared to the earlier years. For NTNU, after around 2005, the average number of papers per unique journal for NTNU seems to be generally higher than for NIE, indicating that NTNU researchers might be focusing their efforts on a smaller set of journals compared to NIE.

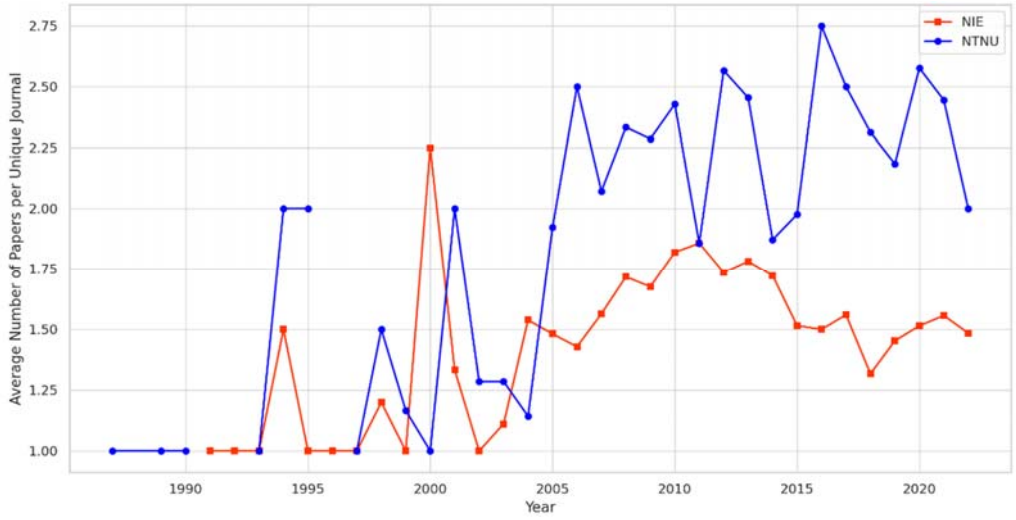


Figure 2. Average Number of Papers Submitted per Unique Journal.

Figure 3 shows increasing trends for NIE and NTNU in average number of authors, title and abstract word counts, and keyword usage per paper. From 2004, NTNU consistently surpassed NIE in these metrics, except for keyword usage where the difference is less pronounced.

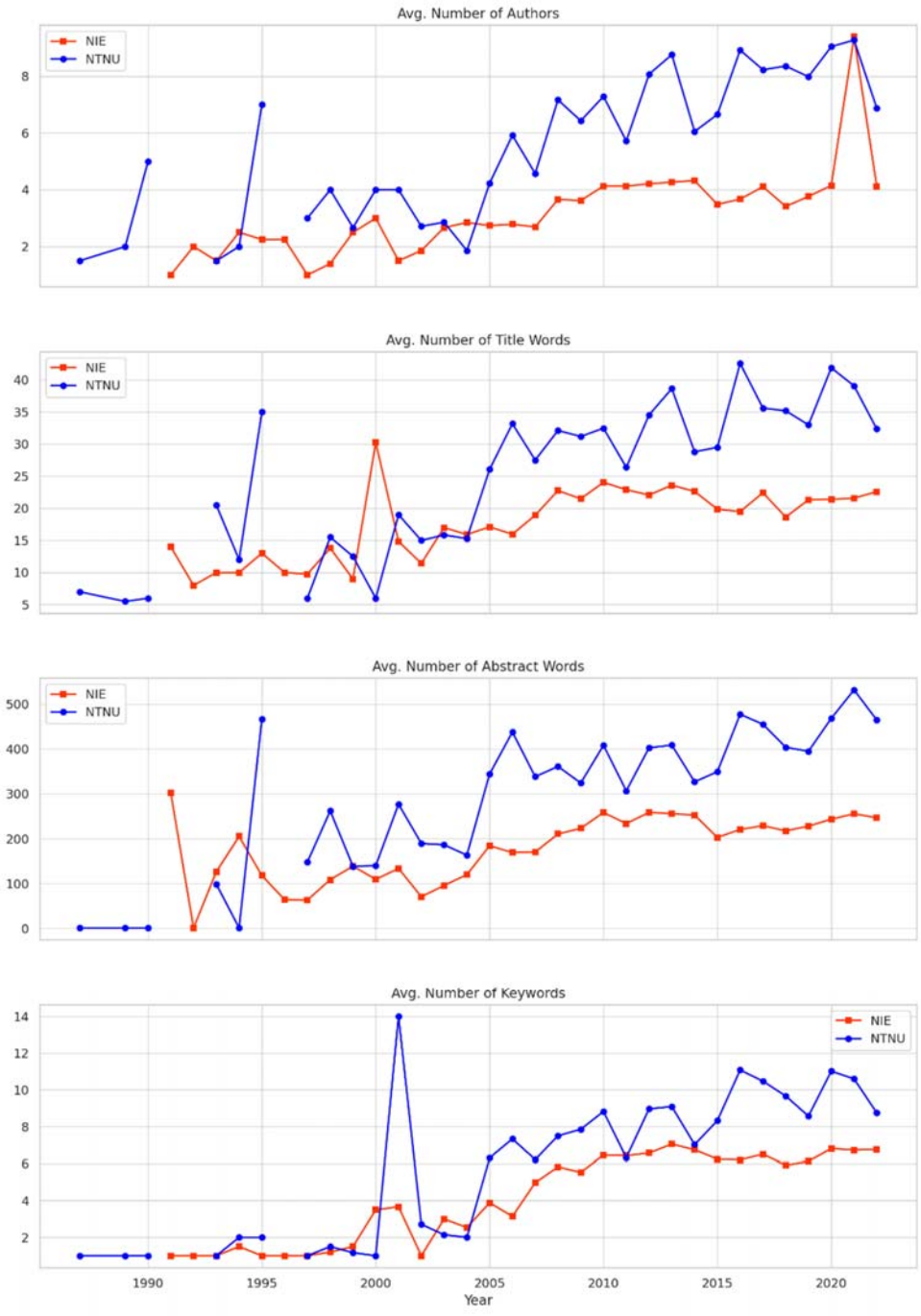


Figure 3. Average Number of Authors, Title Words, Abstract Words, and Keywords Over Time for Both NIE And NTNU

4.1.2 Breakdown of Journal Submissions by University with Qualitative Interpretation

Figure 4 lists the top ten journals for submissions from NIE and NTNU, with "Asia Pacific Journal of Education" and "Journal of Research in Education Sciences" leading for NIE (n=120) and NTNU (n=193) respectively, indicating their prominent role in each institution's research output.

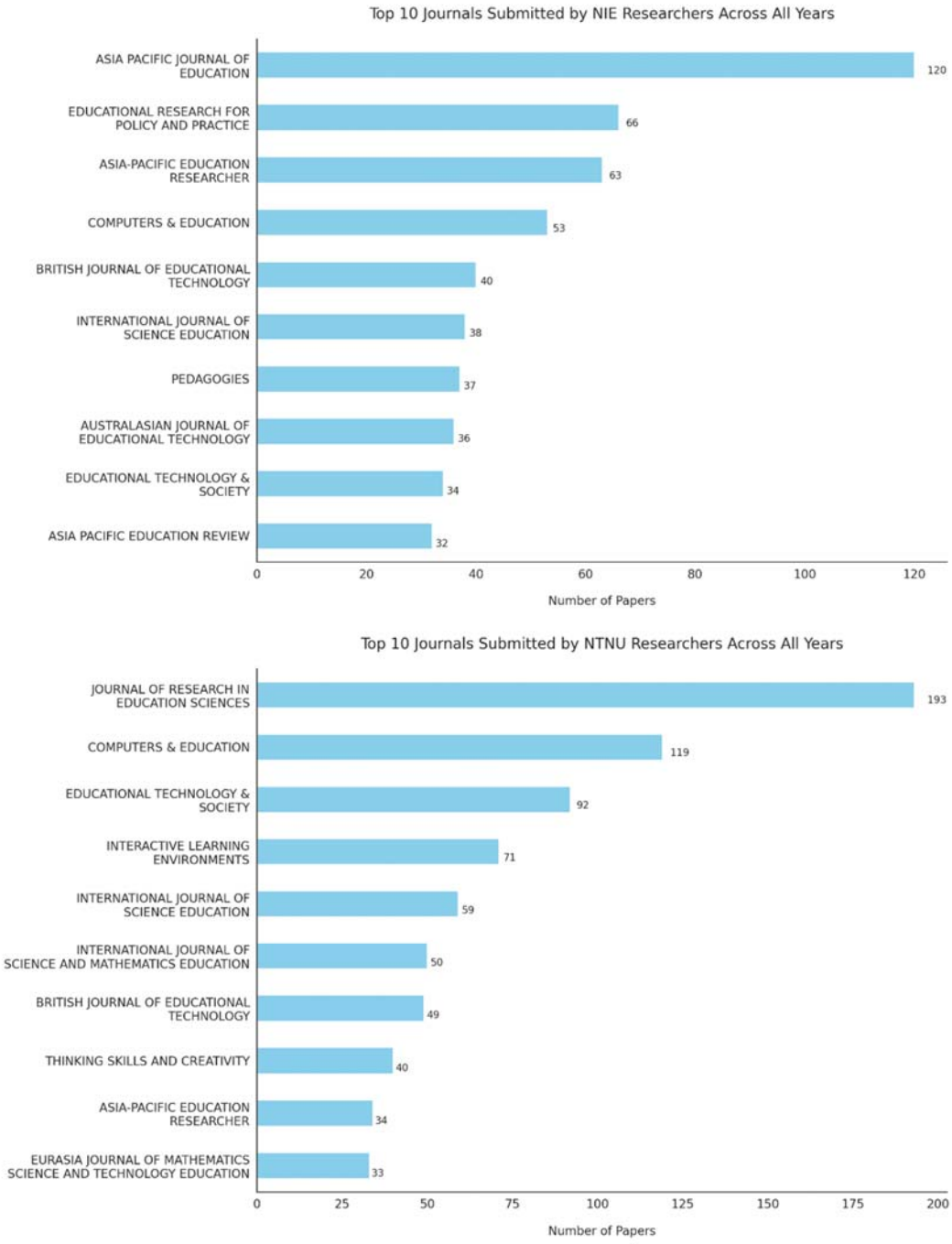


Figure 4. Top 10 Journals Submitted by NIE and NTNU Researchers Across All Years

Figure 5 compares the two universities' top 10 submissions using a heatmap. Each cell's color indicates the quantity, with darker shades representing more papers. The top section shows common journals, the middle, NIE-exclusive, and the bottom, NTNU-exclusive, all ranked by total submissions.

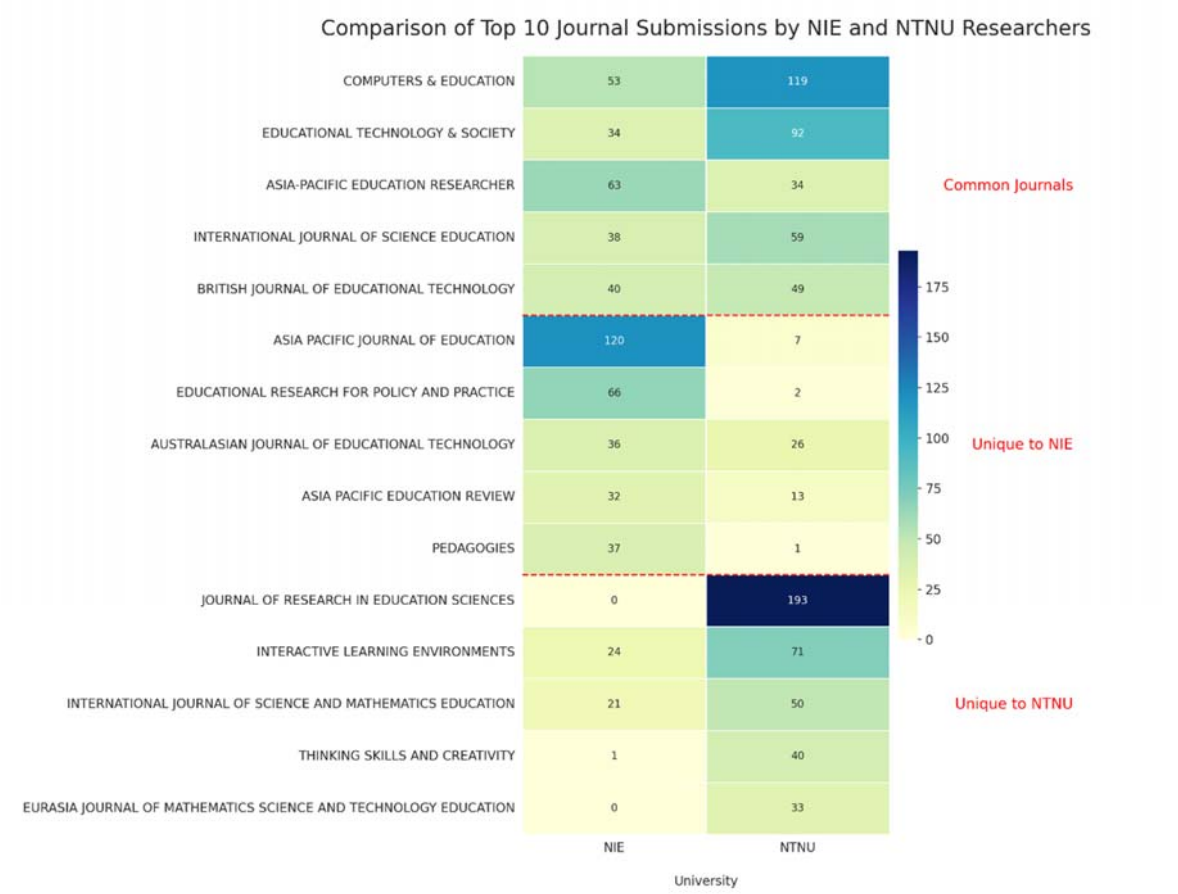


Figure 5.

It shows that both NIE and NTNU researchers frequently submit to five shared journals, with "Computers & Education" and "Educational Technology & Society" receiving the highest total submissions from both universities, indicating a common emphasis on the intersection of education and technology.

Of NIE's top 10 journals, five are not present in NTNU's list. These include "Asia Pacific Journal of Education" (n=7), "Educational Research for Policy and Practice" (n=2), and "Pedagogies" (n=1) with relatively low submission rates from NTNU. On the other hand, "Australasian Journal of Educational Technology" (n=26) and "Asia Pacific Education Review" (n=13) have attracted a more considerable number of submissions from NTNU.

Similarly, five journals that rank in NTNU's top 10 are not featured in NIE's equivalent list. These encompass "Journal of Research in Education Sciences" (n=0), "Thinking Skills and Creativity" (n=1), and "Eurasia Journal of Mathematics Science and Technology Education" (n=0), where NIE's submission rates are notably low. However, "Interactive Learning Environments" (n=24) and "International Journal of Science and Mathematics Education" (n=21) have drawn a substantial number of submissions from NIE.

4.2 Author Keywords Analysis

We found that, of the 6,903 keywords used by NTNU and NIE, only 502 are common, indicating either varied terminology for similar concepts or a broad scope of distinct research areas between the two institutions. Figure 6 shows the top 10 most frequently used keywords across both universities.

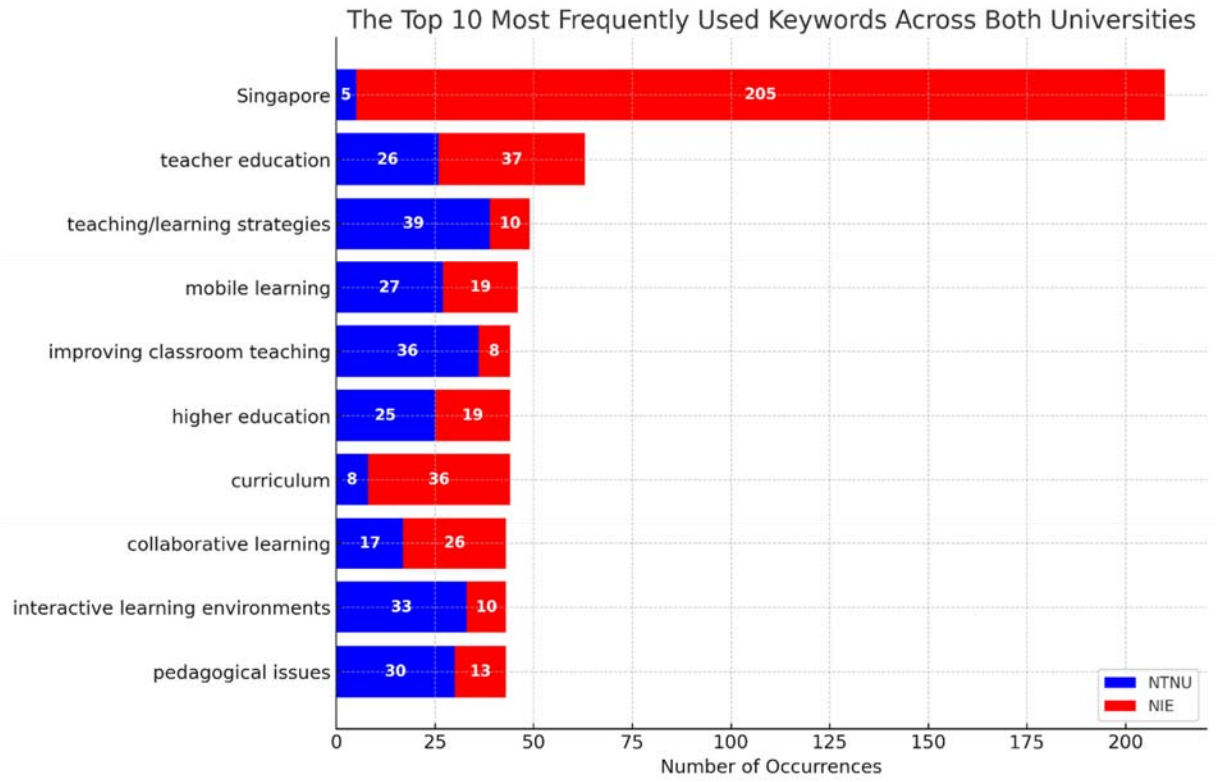


Figure 6.

Figures 7 to 9 chart the top 10 keyword usage from 1999 to 2022. Figure 7 showcases the keywords that top the list when combining the usage from both NTNU and NIE. Figure 8 focuses on NIE's top 10 keywords, also showing NTNU's usage, while Figure 9 does the reverse. Each subplot represents a keyword, with NTNU marked by solid blue lines and circles, and NIE by dashed red lines.

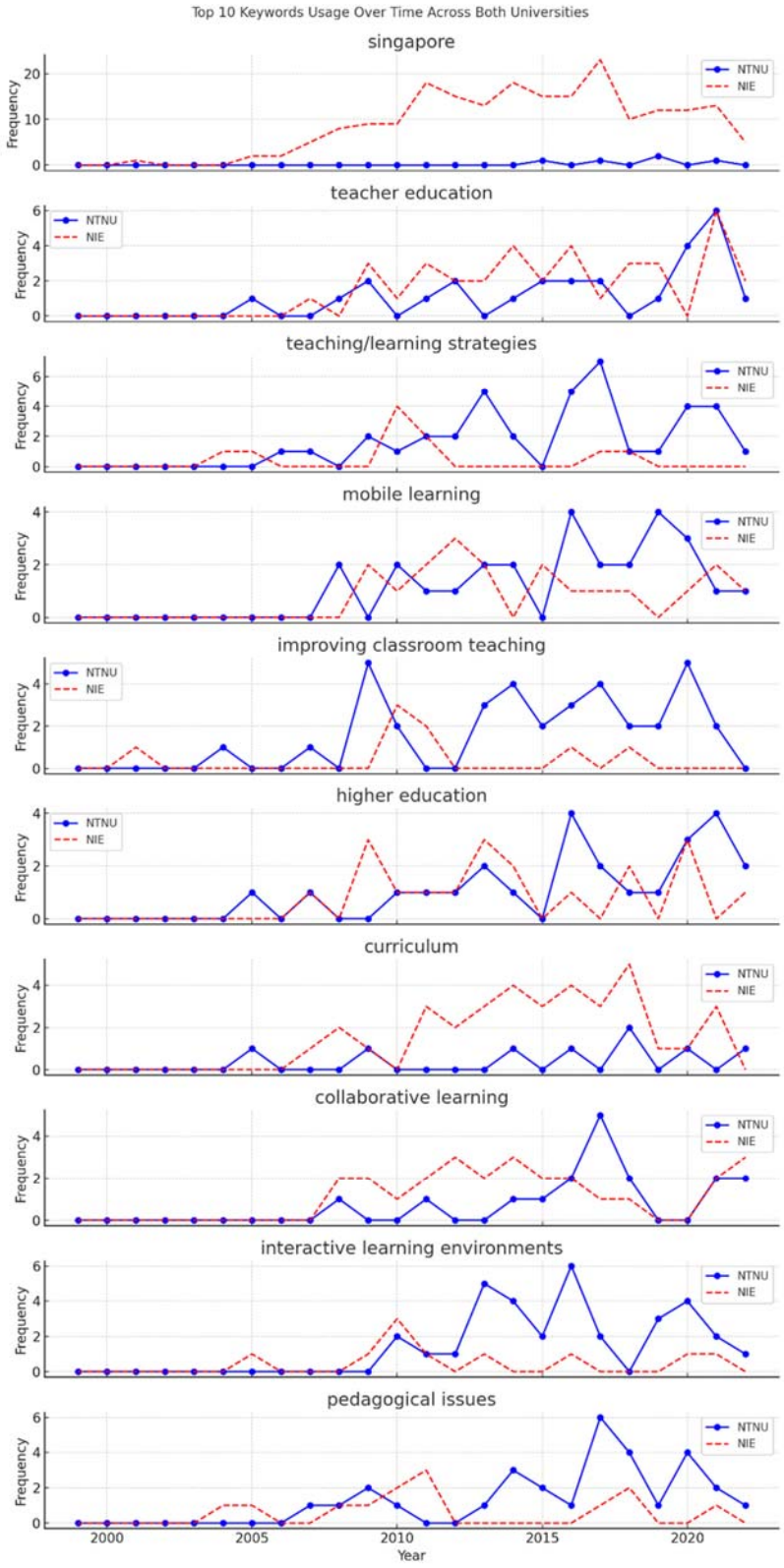

Top 10 Keywords Usage Over Time Across Both Universities
singapore
teacher education
teaching/learning strategies
mobile learning
improving classroom teaching
higher education
curriculum
collaborative learning
interactive learning environments
pedagogical issues
NTNU
NIE
Frequency
Year
2000
2005
2010
2015
2020

Figure 7.

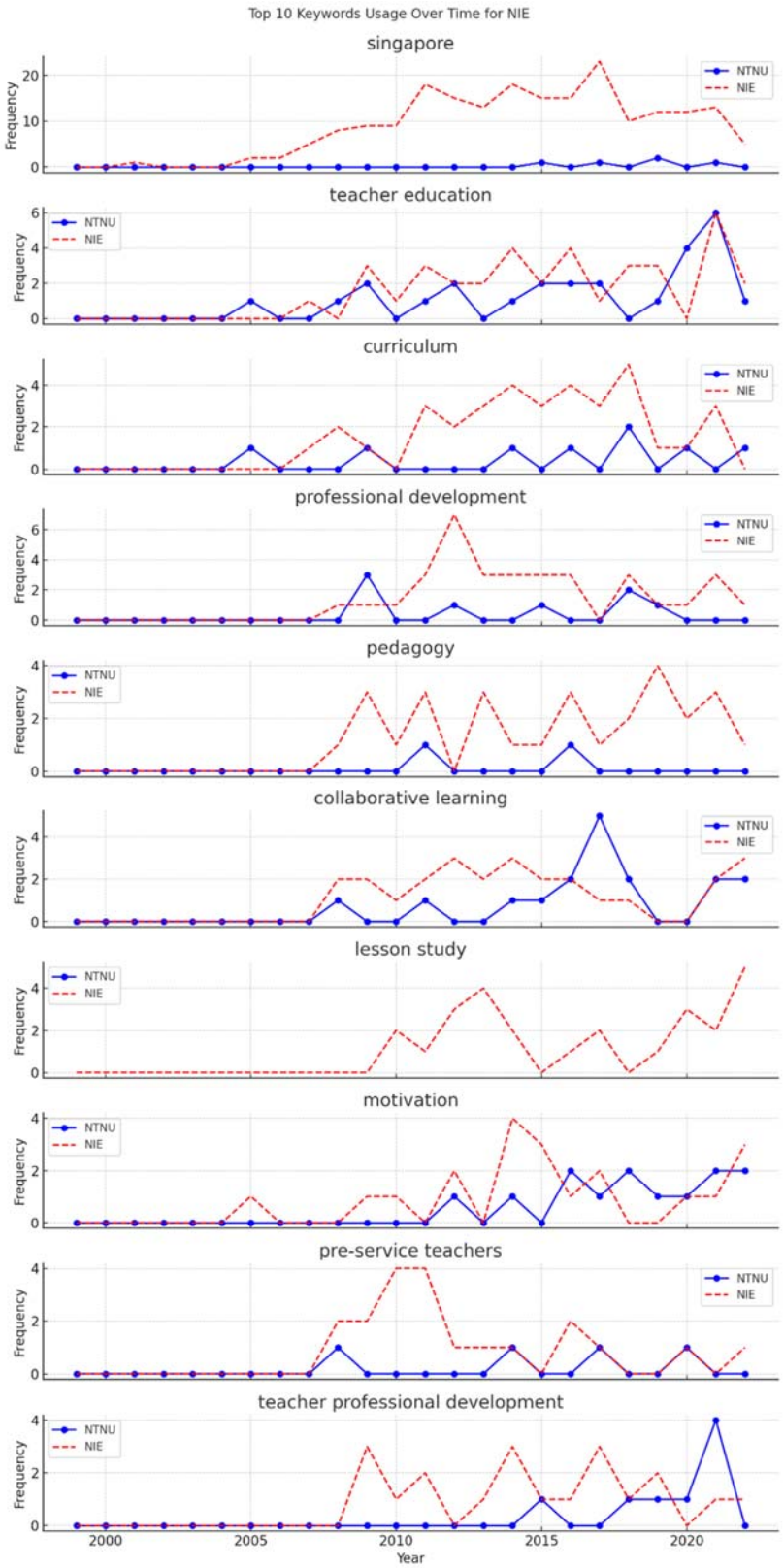

Top 10 Keywords Usage Over Time for NIE
singapore
teacher education
curriculum
professional development
pedagogy
collaborative learning
lesson study
motivation
pre-service teachers
teacher professional development
NTNU
NIE
Frequency
Year
2000
2005
2010
2015
2020

Figure 8

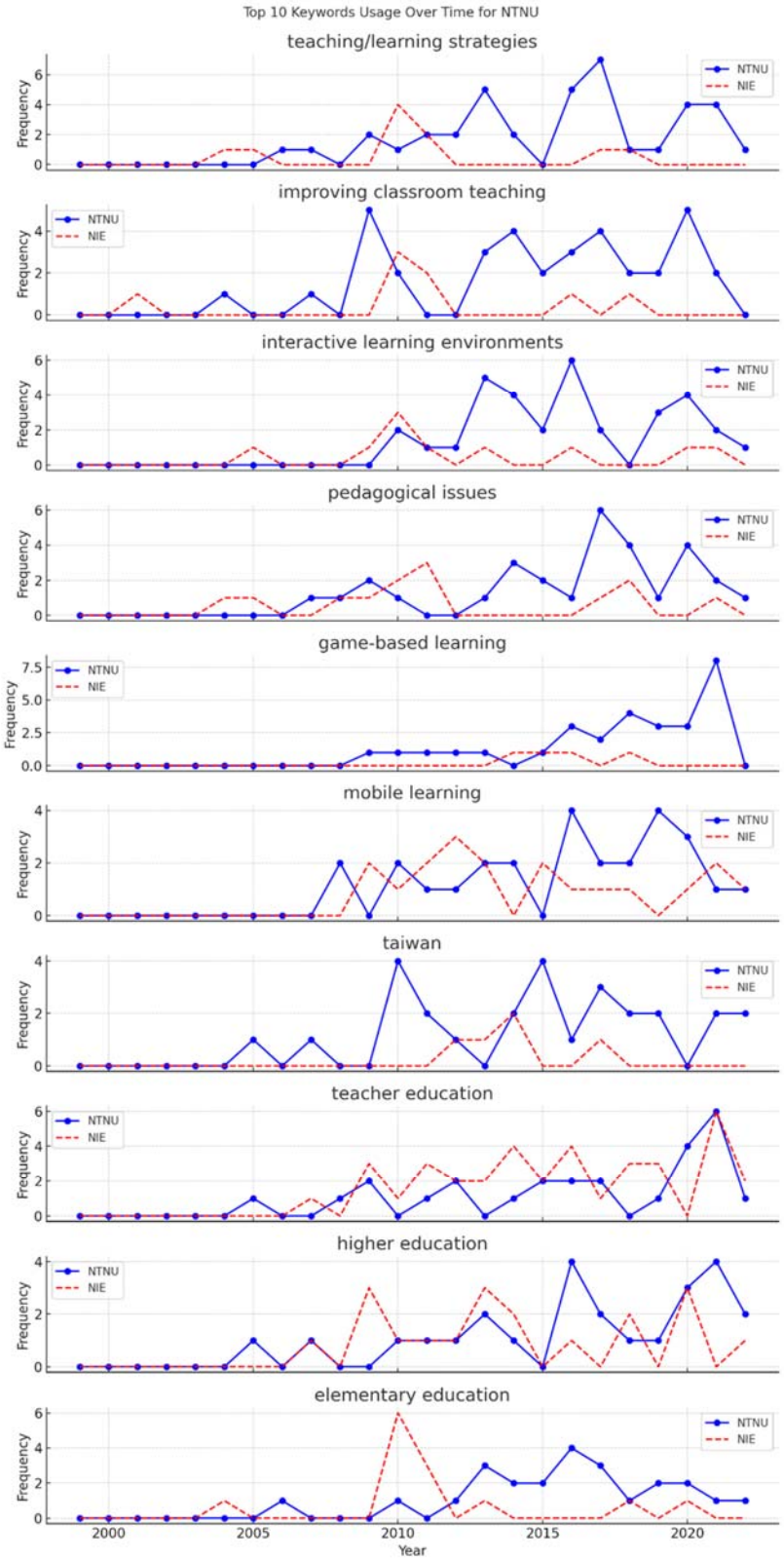


Figure 9. Top 10 Keywords Usage Over Time for NTNU, in Comparison to NIE

Figure 7 reveals the following patterns:

- "Singapore" is a keyword heavily favored by NIE, with usage significantly rising after 2010.
- "Teacher Education" sees consistent usage at both universities, with a slight edge at NIE.
- "Teaching/Learning Strategies" remains a steady choice at NTNU, while NIE's usage is sparse, save for a surge in 2010.
- "Mobile Learning" sees increased interest from both universities from 2008 to 2015. However, while NIE's interest wanes post-2015, NTNU's remains.
- "Improving Classroom Teaching" is more commonly used by NTNU.
- "Higher Education" and "Interactive Learning Environments" find more usage at NTNU, with the latter gaining traction since 2012.
- "Curriculum" is a recurrent theme at NIE, with NTNU's interest relatively low.
- "Collaborative Learning" is more frequently mentioned at NIE, apart from a brief surge at NTNU in 2016-2017.
- "Pedagogical Issues" has been a consistent focus at NTNU since 2006.

Figure 8 highlights that "professional development", "pedagogy", "lesson study", "pre-service teachers" and "motivation" are keywords prevalent in NIE's research, but find minimal usage at NTNU. An exception is "Teacher professional development," which sees a spike at NTNU in 2021.

Figure 9, on the other hand, showcases NTNU's growing emphasis on "Game-based learning" since 2015, a trend not echoed by NIE.

4.3 Paper Classification Using ERIC Categories

Utilizing 41 ERIC categories, we classified 342 papers from NTNU and NIE. Excluding "reviews" and "non-research articles," the most predominant category is "Educational Process: Classroom Perspectives." While NIE primarily focuses on this category, NTNU's primary emphasis lies in "Learning and Perception," as visualized in Figure 10 (with NIE represented by red bars and NTNU by blue bars).

Categories like “Agriculture and Natural Resources,” “Disabilities,” “Health and Safety,” “Labor and Employment,” “Languages,” and “People and Cultures” have minimal representation, with only one paper each. Categories absent for both institutions include 'Business, Commerce, and Industry', 'Counseling', 'Economics and Finance', 'Equipment', 'Facilities', 'Government and Politics', 'Human Geography', 'Occupations', 'Publication/Document Types', and 'Social Problems'.

Figure 10.

In Figure 11, cross symbols represent ERIC thesaurus categories, detailing the distribution of research papers between NIE and NTNU. The cross size reflects the combined paper count for both institutions in that category. Its position indicates whether one institution dominates a category or if the category is exclusive to one institution. For clarity, only categories with more than four papers are labelled.

NIE outnumbers NTNU in these categories: 'Educational Process: Classroom Perspectives', 'Research and Theory', 'Educational Process: Societal Perspectives', 'Mathematics', 'Subjects of Instruction', and 'Bias and Equity'. Conversely, NTNU leads in 'Individual Development and Characteristics', 'Learning and Perception', 'Science and Technology', 'Educational Process: School Perspectives', 'Language and Speech', and 'Arts'.

Exclusive categories for NIE include 'Physical Education and Recreation', 'Social Processes and Structures', 'Students, Teachers, School Personnel', 'Disabilities', and 'Peoples and Cultures'. For NTNU, unique categories comprise 'Communications Media', 'Health and Safety', 'Labor and Employment', 'Languages', 'Reading', 'Tests and Scales', and 'Agriculture and Natural Resources'.

Figure 11. Chart showing ERIC categories that 1) NIE has more papers than NTNU, 2) NTNU has more papers than NIE, 3) are unique to NIE and 4) are unique to NTNU

5. DISCUSSION

5.1 Journal Submission Patterns of NIE and NTNU Researchers

Both NIE and NTNU have experienced an uptick in research outputs, as indicated by an increase in unique publication venues and paper submissions. Specifically, NIE's growth was particularly pronounced from 2008 to 2014 and later reached a plateau, while NTNU observed a steady growth trajectory, especially between 2010 and 2021. These institutional trends mirror the global research landscape. For instance, Tosun (2021) highlighted significant publication surges in 1980, 2008, and 2019. Similarly, Huang et al. (2020) noted an increased publication rate between 2008–2014, with a substantial uptick starting in 2015.

A notable trend in the research from both institutions is the rise in co-authorship, suggesting a move towards collaborative research endeavors. This aligns with findings from Sezgin et al. (2022), who documented an increased prevalence of multi-authorship in educational research, emphasizing its evolving, collaborative, and international character.

Despite these similarities, divergences in publishing strategies between NIE and NTNU have been observed. NIE researchers exhibit a more diverse range of publications and a higher volume of output. In contrast, NTNU researchers, while also prolific, tend to contribute more papers to individual journals than

their NIE peers. This suggests distinct publication strategies or institutional preferences between the two entities.

5.2 Unique and Shared Research Interests of NTNU and NIE Researchers: Insights from Journal Submissions

Research submission data reveals both NTNU and NIE emphasize the intersection of education with technology. Consistent with Tosun (2021), both institutions predominantly submit to "Computers & Education" and "International Journal of Science Education" — reflective of global educational research trends.

Furthermore, when we explore journals receiving significant submissions from both institutions, yet not top-ranked for either, more collaborative potential emerges. Notable shared interests are evident in the "Australasian Journal of Educational Technology" (NIE=36, NTNU=26), "Asia Pacific Education Review" (NIE=32, NTNU=13), "Interactive Learning Environments" (NIE=24, NTNU=71), and "International Journal of Science and Mathematics Education" (NIE=21, NTNU=50). These shared interests, spanning educational technology, science and mathematics education, and interactive learning environments within the Asia Pacific context, could spur collaborative endeavors.

On the other hand, divergences in journal submissions underscore unique research priorities. NIE's frequent submissions to the "Asia Pacific Journal of Education", "Educational Research for Policy and Practice", and "Pedagogies" could suggest a particular emphasis on policy, practice, and pedagogical studies within the Asia Pacific. This aligns with Nylander and Tan (2022), who pinpoint Singapore's research predominantly focuses on pedagogical practices. In contrast, NTNU's substantial submissions to "Journal of Research in Education Sciences", "Thinking Skills and Creativity", and "Eurasia Journal of Mathematics Science and Technology Education" may indicate a focus on creative thinking skills and STEM education.

5.3 Keyword Trends: Distinguishing NIE and NTNU's Research Focuses

A close examination of keyword usage from NIE and NTNU over the years illuminates the evolving research emphases of both institutions:

- **Regional versus Global Focus**: The keyword "Singapore" is dominant in NIE's research, reflecting a strong regional focus. Conversely, NTNU's lower usage of “Taiwan” suggests a more global or non-region-specific research approach. This divergence may indicate NIE's role in shaping Singapore's education system and its commitment to tackling local educational challenges, while NTNU may be oriented towards broader, more universally applicable research.
- **Pedagogical Practices, Strategies, and Issues**: Both universities frequently use "Teacher Education," but their contrasting usage of "Teaching/Learning Strategies," "Improving Classroom Teaching," and "Pedagogical Issues" implies diverging research interests and approaches. NTNU's consistent usage of these keywords suggests a systematic exploration of pedagogical methodologies, instructional enhancement, and broader pedagogical challenges. In contrast, NIE's intermittent usage might indicate a more targeted approach, perhaps focusing on specific strategies or interventions.
- **Technology Integration in Education**: The surge in "Mobile Learning" from 2008-2015 at both universities aligns with the global trend of integrating technology into education. However, NTNU's sustained interest post-2015, coupled with the higher frequency of "Interactive Learning Environments" and the emerging focus on "Game-based learning" since 2015, suggests a continued emphasis on investigating the transformative potential of technology in education. In contrast,

NIE's decreased usage of "Mobile Learning" and lower frequency of "Interactive Learning Environments" might reflect a shift towards other emerging areas of educational research.

- **Collaboration vs. Individual Learning**: NIE's higher usage of "Collaborative Learning" could reflect a belief in the value of social learning strategies. Conversely, NTNU's consistent usage of "Interactive Learning Environments" and "Game-based learning" could signify a focus on individualized, technology-enhanced learning.
- **Profession Development and Higher Education**: The keywords "professional development," "pedagogy," and "pre-service teachers" are more frequently used in NIE research papers, suggesting a higher interest in research areas pertaining to professional development in education. On the contrary, NTNU's negligible usage of these keywords suggests less focus on these topics. Rather, NTNU's higher usage of "Higher Education" could suggest a focus on issues and practices in tertiary education.

5.4 Keyword Patterns in NIE and NTNU Publications vs. Global Trends

Our bibliometric analysis, set against the backdrop of global educational research, reveals both clear parallels and noteworthy differences. A significant alignment is observed in the top keywords from both the global studies by Huang et al. (2020) and Tosun (2021) and our analysis. Terms such as "Higher education", "Interactive learning environment", "Teaching/learning strategies" and "Teacher education" are prominently featured. These keywords underscore universally relevant themes, indicating foundational topics that have widespread resonance in educational research.

However, certain keywords prominent in global studies were notably absent from our top ten list, including "Human capital", "Computer-mediated communication", "Media in education", "Equity and social justice" and "Gender". The absence of digital themes, like "Computer-mediated communication" and "Media in education", might suggest either a different pace of digital adoption or a unique set of research priorities in Singapore and Taiwan. The lack of emphasis on "Gender" and "Equity and social justice" might allude to specific socio-cultural perspectives, implying that these issues might be enveloped within broader topics rather than isolated as separate research avenues. The diminished presence of "Human capital" could suggest a regionally focused, pedagogy-centric research environment, emphasizing the quality and process of education over its economic aspects.

5.5 Insights from ERIC Category Classification: Unique and Shared Research Interests of NIE and NTNU

The distribution of research papers across ERIC categories reveals a strong emphasis by both NTNU and NIE on "Classroom Perspectives", "Learning and Perception", and "Individual Development". Conversely, areas like "Government and Politics", "Economics and Finance", "Counseling", and "Human Geography" seem less prominent in the research outputs from these institutions. However, it's essential to recognize that the absence or scant presence in specific categories doesn't inherently suggest a disinterest or neglect of those areas. For a more holistic comprehension of the research nuances at these institutions, a meticulous examination of individual papers within each category, accompanied by a qualitative content review, would offer deeper insights.

A notable observation from the data is the dominant presence of both institutions within the "Educational Process: Classroom Perspectives" category. NIE's larger volume of papers in this category suggests an especially deep concentration or expertise. Additionally, both institutions have showcased research under "Individual Development and Characteristics", with NTNU slightly ahead. Furthermore, NIE's distribution of papers points towards a highly focused research interest, given that the volume of papers in other categories is markedly less compared to the "Educational Process: Classroom Perspectives"

category. This concentrated approach aligns with literature findings that depict Singapore's research methodology as centralized and practically-oriented (Nylander & Tan, 2022).

In contrast, NTNU displays a more diversified research interest, spanning topics such as "Learning and Perception", "Individual Development and Characteristics", and "Language and Speech". This eclectic approach resonates with Tosun (2021)'s observation of Taiwan as a dynamic contributor in diverse educational fields, covering domains like "Teaching Strategies", "E-Learning", "Pedagogical Issues", and more.

6. CONCLUSION & FUTURE WORK

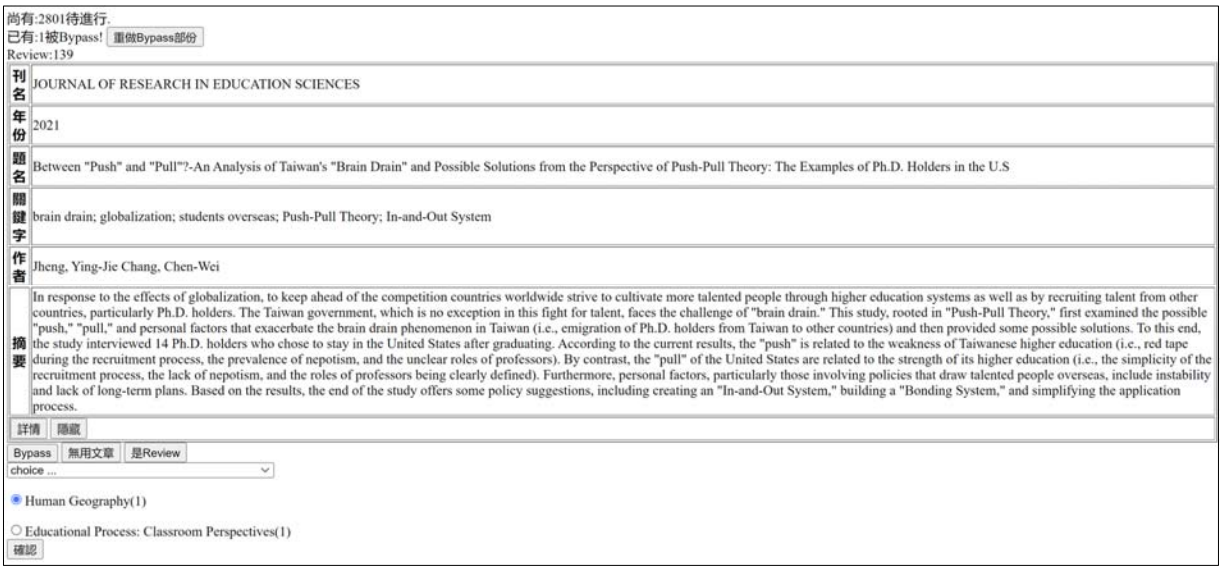
Our analysis of research outputs from NIE and NTNU over the years has provided insights into their evolving academic landscapes. *Publication Dynamics*: Both NIE and NTNU have witnessed growth in their research outputs, reflecting a broader global trend. There's evident variability in publishing strategies, with NIE showcasing greater publishing diversity, while NTNU researchers frequently submit to specific journals. *Keyword Analysis*: Analysis of top journal submissions indicates a shared emphasis on the intersection of education and technology. However, specific journals hint at potential collaboration areas and unique research focus points for each institution. There are shared and distinct keyword trends between NIE and NTNU, reflecting both shared concerns and unique institutional priorities. Globally resonating themes like "Higher Education" and "Interactive Learning Environment" are consistently prevalent in research from both institutions. Yet, there are clear regional deviations, with keywords like "Human Capital" and "Gender" less frequent in Singaporean and Taiwanese research. *ERIC Category Insights*: A strong research emphasis at both institutions centers on "Classroom Perspectives", "Learning and Perception", and "Individual Development and Characteristics". However, the distribution reveals a more specialized focus for NIE, whereas NTNU has a more diversified interest.

In summation, while NIE and NTNU both contribute substantially to global educational research trends, they also manifest distinctive research priorities. Their collective output emphasizes not just global themes but also region-specific nuances, possibly influenced by their respective socio-cultural and institutional contexts.

A first future work includes expert validation, which is to engage NIE and NTNU researchers to validate and contextualize the study's findings. Their insights can help confirm whether the keyword usage trends identified align with their lived institutional experiences and domain knowledge. Where discrepancies exist, they can provide valuable explanations and identify factors driving the evolution of research focus over the past two decades.

A second direction would be a more in-depth analysis of the keyword dataset using advanced machine learning techniques. A word embedding model, such as Word2Vec, could be employed to analyze semantic similarities between different keywords, potentially unearthing related research themes across a broader scope. Network analysis could further be applied to the co-occurrence of keywords to elucidate the structure and interconnections between research topics at the two universities. This could reveal unique insights into the evolution and interrelation of research themes over time.

APPENDIX. Interface Of the Automated Content Classification System



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