The Similarities and Differences between Humanities and Social Sciences in Taiwan's Initiative to Embrace Educational Digitization: Issues, Delivery, and Tools

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Abstract: - This comprehensive study delves into technology integration competencies within humanities and social sciences (H&SS) education, using the Technological Pedagogical Content Knowledge (TPACK) framework as its guiding lens. Through a careful analysis of course syllabi from higher education institutions in Taiwan, this research reveals distinctive patterns of emphasis across seven key TPACK knowledge domains. While both humanities and social sciences educators acknowledge the importance of integrating technology into their teaching and subject matter, subtle differences emerge. Humanities instructors tend to prioritize Pedagogical Content Knowledge (PCK), aligning this choice with their primary goal of conveying narratives and preserving cultural heritage. Conversely, their counterparts in social sciences lean more toward highlighting Technological Pedagogical Knowledge (TPK), reflecting the importance of understanding social phenomena in their field. This study underscores the pressing need for the development of tailored professional development initiatives and a revamp of pre-service teacher education programs, both of which should prioritize domain-specific TPACK competencies. This study highlights the critical importance of grounding training within authentic design tasks to effectively nurture TPACK. It points toward promising future research avenues, including investigations into the practical translation of TPACK understanding into classroom implementation and subsequent student outcomes. By shedding light on these distinctions, this research provides valuable insights for enhancing digital literacy and delivering technology-enriched learning experiences in the realm of H&SS education.

Key-Words: -Content Analysis, Data Mining, Digital Humanities, Educational Technology, Online Learning, Teacher Education, TPACK Framework

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1 Introduction

Educational technologies have fundamentally transformed teaching approaches, requiring instructors to re-envision curriculum design and instructional practices. However, research indicates that effective technology integration in classrooms remains challenging, especially for humanities and social science (H&SS) educators [1–3]. Studies have uncovered gaps in digital literacy among H&SS teachers compared to technical fields like computer science and engineering [4–6]. Deficiencies exist across areas including computational analysis, data science skills, and programming knowledge [7–9]. This persistent "digital pedagogy divide" results from inadequate training opportunities and lack of relevant teaching frameworks tailored to H&SS contexts [10–12].

Technological Pedagogical Content Knowledge (TPACK) emerged as an important theoretical model for examining technology, pedagogy and content knowledge intersections [13]. However, most TPACK research has focused on Science, Technology, Engineering and Math (STEM) contexts, with limited application in humanities and social science classrooms [14–16]. Furthermore, few studies have conducted comparative analysis of variances in TPACK knowledge between academic disciplines [17]. This study aims to address these gaps by investigating TPACK skills and integration approaches in Taiwanese university humanities and social science courses.

Specifically, we aim to answer:

RQ1: What are the differences in TPACK knowledge, focus and integration patterns between humanities and social science instructors?

RQ2: How does TPACK application vary across H&SS disciplines?

RQ3: What recommendations can be made to improve TPACK based on identified competency gaps?

This large-scale comparative analysis of 189 courses provides empirical insights into variances between fields. Our findings provide guidance for tailored TPACK training for H&SS educators making an important empirical contribution to the under-examined area of digital pedagogy in humanities and social sciences.

2 Literature Review

2.1 TPACK Framework and Digital Literacy Divide

Rooted in Shulman's Pedagogical Content Knowledge concept [18], Mishra and Koehler formulated the TPACK framework in 2006 [13]. It delineates seven key knowledge domains: Technology Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) [13]. TPACK represents the complex interplay of technology, pedagogy and content knowledge. Schmidt et al. summarize TPACK as the specialized knowledge teachers need to meaningfully integrate technology in instruction [19].

However, scholars emphasize TPACK requires more than an additive overlay of the three knowledge domains [20]. The intersections produce situated, context-dependent knowledge suited to one's discipline [21, 22]. Effective technology integration requires comprehending the nuanced relationships between technology, pedagogy and content within particular teaching contexts [13, 23]. This necessitates cultivating TPACK aligned with one's educational context and subject matter [13].

Nevertheless, studies reveal alarming digital literacy gaps among humanities and social science educators across international contexts [4, 7–9]. Abrosimova et al. [4] noted the shortage of qualified faculty to teach emerging technologies like virtual reality in humanities contexts. Analyzing teachers across disciplines in Nigeria, Richard [5] reported low competence in utilizing ICT tools, underscoring the need for intensive digital skills training tailored to local contexts.

These technical weaknesses result from insufficient preservice training and professional development opportunities designed for H&SS [10, 12]. Howard et al. [10] emphasized one-time technology workshops are inadequate, calling for continuous TPACK-focused teacher education. Angeli et al. proposed an e-TPACK framework for sustained, mentor-guided TPACK development through e-learning. However, Abid et al. [9] noted the scarcity of contextualized models to cultivate humanities educators' digital literacy. As Pondee et al. concluded, "Effective use of technology for H&SS teaching is constrained by the lack of training in digital literacy and TPACK tailored to discipline needs" [11].

2.2 TPACK Investigation in Humanities and Social Sciences

While TPACK has gained popularity as a technology integration framework, its application in humanities and social science education remains limited thus far [14, 17]. Most studies have focused on preservice teacher training or STEM disciplines [16, 24–26]. In comprehensive reviews, Chai et al. [27] and Cahapay [15] found minimal TPACK research situated in humanities contexts compared to other fields.

Among the few studies, Mishra et al. [28] traced teachers' TPACK development through analysis of humanities course design discourse patterns. Howard et al. [10] offered recommendations for improving preservice teachers' TPACK in H&SS contexts using case-based methods. In foreign language education, Inpeng and Nomnian [29] examined TPACK principles in integrating social media.

However, scholars continue to emphasize the need for more TPACK research focused on humanities and social science education [14, 17]. As Mouza [30][32] stated, "We need more TPACK studies focusing on...the social studies, language arts, foreign languages, music, and visual arts." Barr [17] asserted "TPACK research in the humanities is underrepresented." Our study helps address this gap by investigating TPACK among Taiwanese humanities and social science educators.

Furthermore, few studies have conducted comparative analysis of variances in TPACK knowledge between academic disciplines [17]. Pondee et al.'s study [11] comparing science teachers represents one of the few examples. Our robust cross-disciplinary analysis provides empirical insights into potential divergence in H&SS educators' digital literacy and integration approaches. These findings may inform development of tailored, discipline-specific TPACK training.

2.3 Research Context

This study is situated within a major humanities and social science digital education initiative launched by Taiwan's Ministry of Education (MOE) from 2017-2021. The program funded over 189 technology-integrated courses across Taiwanese universities to enhance digital literacy. An expert panel selected the courses, representing diverse, high-quality examples of technology use in H&SS instructional contexts. This large-scale dataset provided a substantive basis for comparatively analyzing TPACK integration patterns between humanities and social science educators based on actual course designs. The Taiwanese setting represents an under-examined yet valuable context for extending TPACK research to new geographic and cultural spheres.

3 Research Methods

This study utilized rigorous content analysis methodology to systematically investigate and compare TPACK knowledge and integration approaches between humanities and social sciences instructors.

3.1 Dataset

Our empirical analysis focused on detailed curriculum and course descriptions from 189 technology-enhanced humanities, social science, and scientific methods courses funded through Taiwan's MOE digital literacy initiative from 2017-2021. This robust dataset encompassed courses across diverse disciplines within the humanities and social sciences.

3.2 TPACK Coding Scheme

We developed a rigorous coding scheme aligned with the TPACK framework by Mishra and Koehler [13] to categorize the textual curriculum data. Two researchers independently coded the course syllabi contents into seven TPACK domains (see Table 1): Technology Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Content Knowledge (TC), Technological Pedagogical Knowledge (TP), Pedagogical Content Knowledge (PCK) and Technological Pedagogical Content Knowledge (TPCK). Intercoder reliability was established through iterative calibration and consensus building on a subset of data.

Table 1. Coding Rules

Codes	Coding Description	Examples
C	Only H&SS knowledge is involved in the discourse content.	There are three ways to do mine data.
P	The discourse content relates only to general pedagogical knowledge.	Let students understand the application of Python.
T	The course content description only involves digital information technology knowledge.	We will use PPT, and ...
TC	The course content description involves the connection and interaction between information technology (T) and subject knowledge (C).	We use sketch boards to draw an image.
TP	The course content description involves the connection and interaction between information technology (T) and pedagogical knowledge (P).	We added images to the introduction session to get students' attention.
CP	The course content description involves the connection and interaction between mathematical subject knowledge (C) and pedagogical knowledge (P).	We can use it in life.
TCP	The course content description involves the connection and interaction of subject knowledge (C), information technology knowledge (T) and pedagogical knowledge (P).	We can use drawing software in Mona Lisa

Table 2 shows the total number of codes and their percentages in all codes following our coding process, as well as the frequency and percentage with which each code appears in the course descriptions of all 189 courses.

Table 2. Summary of Codes

Code	Count	% Codes	Cases	% Cases
C	25	2.9%	22	11.6%
P	424	49.4%	158	83.6%
T	18	2.1%	15	7.9%
CP	16	1.9%	15	7.9%
TC	122	14.2%	99	52.4%
TP	20	2.3%	16	8.5%
TCP	233	27.2%	160	84.7%

3.3 Qualitative Analysis

Data were imported into Wordstat, a specialized tool for content analysis, to facilitate the categorization of subjects according to predefined codes, namely C, P, T, CP, TC, TP, and TCP. Utilizing Wordstat's capabilities, we conducted a frequency analysis of specific words and phrases to derive meaningful subject categories through word co-occurrence methodologies. The underlying computational algorithm identifies words that co-occur within the same article or sentence, thereby inferring topical similarity. The normalized Pointwise Mutual Information (PMI) value serves as an indicator of the strength of word co-occurrence within a given topic. For example, the frequent co-occurrence of the terms "population" and "aging" within the same sentence underscores the importance of the subject of population aging within that particular topic. Subsequently, the research team engaged in a meticulous review of thousands of words and phrases within these topics to ensure accurate representation. Ambiguities regarding the inclusion of specific words or phrases were resolved through contextual analysis.

3.4 Triangulation of Findings

This mixed-methods approach facilitated a robust triangulation of the differences and relationships in TPACK knowledge, focus, and integration approaches between the disciplines. While the quantitative analysis provided a broad overview and generalizability, the qualitative analysis offered nuanced, contextualized insights into teacher competencies.

4 Results

Our comparative analyses revealed several key differences in TPACK focus and integration patterns between humanities and social science instructors based on examination of course design data.

4.1 Overview of TPACK Focus Across Academic Disciplines

Our aggregated data analysis reveals distinct patterns in the emphasis placed on various TPACK components across humanities and social science courses. Specifically, both disciplines showed a marked focus on Pedagogical Knowledge (PK) and Technological Pedagogical Content Knowledge (TPCK), while comparatively lesser attention was given to Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK). Figure 1 shows that P and TCP account for approximately one-third of the total internal volume across all three categories and the proportions of the remaining four groups, C, T, CP, and TP, range from 1% to 6.8% of the total internal volume, respectively. This indicates that when discussing these courses, teachers of the three kinds of courses highlighted pedagogy (P) and integration of digital technology pedagogy (TCP) the most, followed by how to integrate digital technology with course content (TC). However, teachers provided less detail regarding the interaction between T, TP, C, and CP.

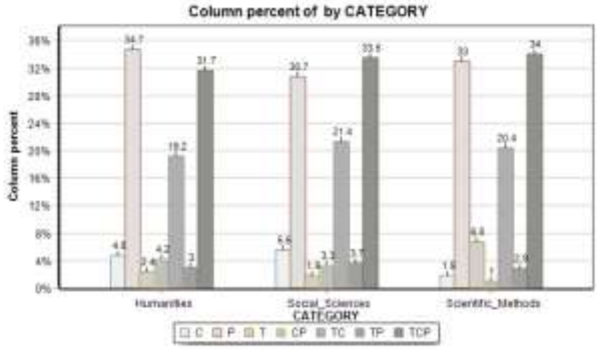

Fig. 1: TPACK by Field

Interestingly, social science courses demonstrate a more evenly distributed focus across all TPACK domains, suggesting a more holistic approach to integrating technology, pedagogy, and content knowledge.

4.2 In-Depth Statistical Analysis of TPACK Codes

To delve deeper into the observed patterns, we employed chi-square tests of independence to examine the relationships between TPACK codes and course categories (see Table 3).

Table 3. P and TCP usages

TPACK Code	Chi-Square Value	p-value	Interpretation
P	19.18	0.000	Significant Association
C	2.95	0.229	No Significant Association
T	4.75	0.093	No Significant Association
CP	2.68	0.262	No Significant Association
TC	0.88	0.645	No Significant Association
TP	0.97	0.616	No Significant Association
TPC	43.01	0.000	Significant Association

The chi-square values for Pedagogical Knowledge (P) and Technological, Pedagogical, and Content Knowledge (TPC) were 19.18 and 43.01, respectively, both with p-values of 0.00. These results lead us to reject the null hypothesis, confirming a significant association between these codes and the course categories under study. For the remaining TPACK codes (C, T, CP, TC, TP), the p-values exceeded 0.05, indicating insufficient evidence to establish a significant relationship with the course categories.

4.3 Comprehensive Cross-Tabulation and Correspondence Analysis

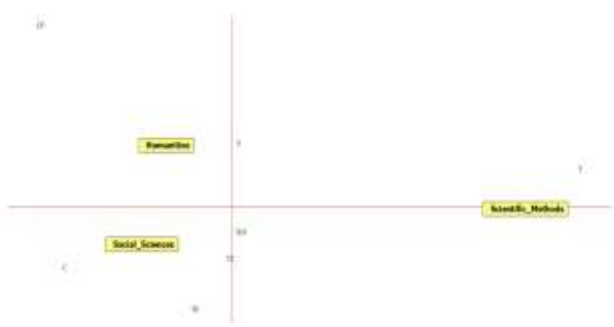

Fig. 2: Crosstabulation Results

Figure 2 offers a nuanced view of the cross-tabulation of TPACK codes across three distinct course categories. The correspondence analysis further elucidates that, among all subsidized courses, social science courses provide the most comprehensive descriptions for four out of the seven TPACK components. Conversely, humanities courses were found to concentrate predominantly on pedagogical aspects, while science methods courses displayed a focus on technological components.

4.4 Integration of Specific Technologies

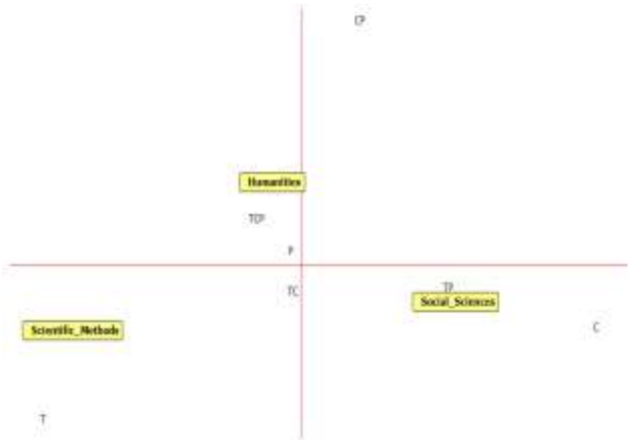

Fig. 3: Crosstabulation results of technology

Figure 3 shows the results of an examination of explicit technology integration. It reveals distinct preferences for certain tools and digital activities aligned with discipline-specific goals and contexts. Humanities course descriptions mainly emphasized TCP, P and TC, while social sciences courses mainly emphasized more on TP and C. The descriptions of TPACK by teachers of scientific methods courses basically focused more on the technical aspects of T.

4.5 Pedagogical Knowledge Analysis

Table 4. Topics in Pedagogy

Topic	Keywords
Classroom Material	Classroom; Materials; Planning; Teaching; Analysis; Explaining;
Cultivation community	Cultivation; Community; Observation; Teaching; Reading;
Expert Invitation	Expert; Invitation; Research; Lecture; Professor; Achievement;
Brainstorm	agitation; brain power; industry division;
Problem Solving	problem; solution; caring; professional; orientation;

Table 4 displays the top five pedagogical techniques referenced in the course descriptions, revealed through rigorous keyword analysis. It illuminates a shift away from traditional comprehension-focused teaching towards more analytical reasoning and active, experience-based learning.

Specifically, Classroom Material reflects a teacher-directed strategy but was only mentioned in some course descriptions. Meanwhile, learner-driven pedagogies were prominently featured. Cultivation Community has students directly observing and interacting with local contexts to gain first-hand cultural understanding. Problem Solving develops analytical skills by having learners investigate authentic issues and generate solutions. Brainstorming nurtures evaluative thinking by synthesizing diverse viewpoints.

These strategies indicate a shift beyond just comprehension towards more analytical reasoning compared to traditional teaching in the digitized humanities and social sciences courses. The pedagogies showcase community and industry-connected experiences rather than isolated classroom learning. For instance, humanities courses emphasized Cultivation Community while social sciences prioritized Problem-Solving approaches. This demonstrates customized pedagogical orientations, while maintaining some classroom teaching traditions.

Figure 4 further elaborates pedagogical differences between disciplines. Humanities courses emphasized Cultivation Community approaches, aligning with humanities goals of elucidating culture and the human experience through situated engagement. Social sciences prioritized Problem Solving strategies, fitting aims to model social phenomena and assess policy impacts. Both leverage customized active learning pedagogies suited to their domains while enhancing analytical, evaluative skills. Additional details on the specific strategies would provide deeper insights into how educators are adapting their approaches for digitally-enhanced education.

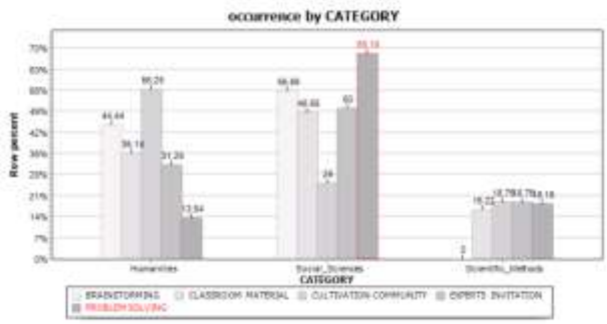

Fig.4: Pedagogy Knowledge by Field

In summary, the results showcase adoption of field-relevant pedagogies beyond passive learning. This analysis provides a valuable window into the student-centered, analytical instructional approaches educators view as important for digital humanities education. Further investigation is warranted into how enhanced pedagogies translate into positive learning outcomes.

4.6 Technology and Content Pedagogy Knowledge

Table 5. Topics in Technology and Content Pedagogy

Topic	Keywords
Social politics economics	Parliament; deepening; information technology; links; awareness; Practice; politics; In-depth; Community; Focus; Advanced; Theory; language; System; Actual; public opinion; utilization; elections; Data Science; Society; Experience; R; public opinion; Collection; Lead; elections; skills; Understanding; training; Research; Surveys; Projects; Information; literacy; Explore; studio; Advanced; Empirical; Theory; political science; Use; politics; management; Tools; architecture;
Local	Region; Literature; Logic; shooting; Transmission; digitalization; Context; Text; place; Schemes; stories; Strengthening; Problem solving; In-depth; Imagery; depth; Search; Development; Diversity; Humanities; issues; Establish; Think; knowledge; platform; Modules; unity; AR; Films; tourism; on the ground; sightseeing; modeling; Guided tours; ..app; collocation; interaction; Groups; production; Resources; formation; Teachers; Reporting; Culture; digital tools; platform; Games; Literature and history; Thoughts; works; Rendering;
Robotics fintech	Robots; fintech; Finance; Thoughts; Mode; Commercial; Import; innovation; Action; Thinking; Empirical; ..ai; Creativity; Development; Teaching; ..app; Explore; Social; Cases; Think; Smart; Encourage; technology; interface; Practitioners; Impact; Including; development; field; Understand;
Cross-culture	cross-cultural; VR; Virtual; Impact; Communication; era; Reality; Common; Space; Guided tours; participation; Understand; Teaching; Industry; digital humanities; Lead;
Enterprise	Enterprise; teachers; Industry; cooperation; Practitioners; Guidance; Special topics; Share; Case-by-case cases; Display; Huge amount of data; Information; links; grouping; discussion; Industry-university; Binding; Teaching; Practice; Results; advertising; brand; facebook; Consumers; promotion; Website; Media; Open; marketing; Operations; Activities; Community; Data; Instantaneous; Industry-university; Reporting; End of period
Automatic artificial intelligence	Automatic; artificial intelligence; Music; python; Specialists; programming language; Scholars; machine learning; AI; Principle; auxiliary; Introduction; Published; software; System; writing; Robots; geographic information;
Program interactive creation	Procedures; interaction; works; Design; training; Entities; units; picture books; Orientation; Journey; Operations; self-directed learning; form; Thinking; Creation; Games; Aesthetics; Theme; structure; Integration; Field; cross-cutting; skills; cross-domain;

The topics shown in Table 5 showcase practical, applied digital humanities curriculum being promoted by Taiwan's Ministry of Education. The integration of verbs and nouns in the keywords also reveal how teachers are combining technical skills, content, and pedagogical aims. For instance, Cross-Culture pedagogy includes learning tours, task assignments, and cultural teachings. The prevalence of these technology-content-pedagogy connections demonstrates conscious efforts to link digital capabilities with humanities and social science disciplinary goals.

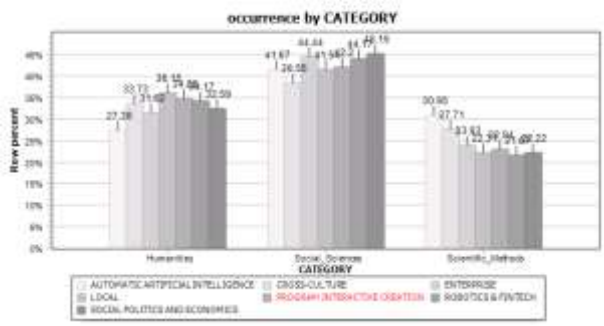

Fig. 5: Technology and Content Pedagogy Knowledge by Field

Figure 5 further illustrates integration of technology-content-pedagogy across disciplines. While all seven themes were present in both humanities and social sciences courses, Cross-Culture was least prevalent at only 38% in social sciences. The breadth of topics covered demonstrates comprehensive efforts to foster content-specific digital literacy and applied skills among both faculties. Additional research into how students respond to customized technology integration approaches could further validate these pedagogical decisions.

In summary, conscious linking of technology tools and content knowledge with pedagogical strategies appears widely applied in the digitized humanities and social science courses. Educators seem cognizant of the need to move beyond passive learning about technology to active application of digital capabilities for enriching field-specific understanding. Continued progress in this direction will require sustained professional development and cross-disciplinary sharing of successful pedagogical strategies.

4.7 Technology and Content Knowledge

Table 6. Topics in Technology and Content

Topic	Keywords
Politics economy media	Politics; Software; Nowadays; Era; Community; Combine; Media; Theory; Life; Information; Phenomenon; Immediate; Policy; Decision-making; Media; Value; Community; Society; Information; Analyse;
Humanistic literacy	Humanities; Field; Innovation; Knowledge; Society; Attainment; Multivariant; Mode; Culture; on the ground; Specialized; on the ground; Multivariant; Theory;
Industrial integration	Enterprise; Study; System; Marketing; Exploitation; Found; Analyse; Industry; Products; Operations; Target; Marketing; Serve; Exploitation; big data;
Ecosystem	Environment; Significance; Space; Life; Technology; Develop; Process; System; Society; History;
Cross-disciplinary	Cooperate; Ability; Attainment; cross-cutting; Process; Educate; Digit;
Traditional resources	Tradition; Resource; Technology; digital tools; Digit; Apply; Interaction; Develop;
Big data AI tools	Data; Artificial intelligence; Foundation; big data; Information;

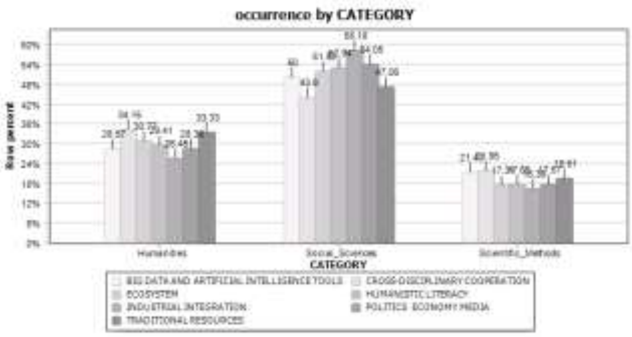

Fig. 6: Technology and Content Knowledge by Fields

Table 6 outlines seven core themes related to the connections between technology and humanities/social sciences subject matter. Figure 6 further elaborates the differences between disciplines. While humanities comprised approximately 30% of technology-content descriptions, social sciences accounted for 50%. Social sciences also referenced a wider span of themes, indicating more comprehensive integration approaches. Additional training focused on humanities-specific technology applications could help balance these discrepancies. The breadth of topics and relatively high frequencies signify both instructors and reviewers emphasize integrating digital skills with disciplinary content. Making connections between emerging technologies and field-specific knowledge appears widely applied. Lower emphasis in humanities suggests more progress may still be needed on cultivating content-specific technology literacy among some faculties.

In summary, deliberate linkage of digital capabilities with subject matter expertise appears strongly prioritized in digitized humanities and social science education. But the variance suggests humanities may require more tailored support to permeate technology throughout the breadth of the field. Further research should probe optimal mechanisms for strengthening technology-content synergies across diverse disciplines.

4.8 Association between TC and TCP Codes

To assess the association between the TC and TPC codes, we conducted a Chi-Square Test for Independence with Spearman Rank Correlation (see Table 7).

Table 7. Association between the TC and TPC

Test	Statistic	p-value
Chi-Square Test for Independence	51.43	0.000
Spearman Rank Correlation	1.00	0.000

Table 7 displays the statistically significant relationship between Technological Content Knowledge (TC) and Technology-Pedagogy-

Content Knowledge (TCP) evident across the courses. The extremely small p-values indicate strong correlations, not due to chance. The correlation coefficient of 1 reflects a perfectly positive relationship between TC and TCP frequencies.

These quantitative findings provide empirical evidence that increased instructor focus on technology-content links strongly correlates with more pervasive implementation of overall TPACK connections. Developing teachers' skills in identifying and leveraging technology-content intersections appears to facilitate broader TPACK integration. This affirms the interconnected nature of TPACK's knowledge domains, quantitatively demonstrating the cascading benefits of enhancing technology-content synergies.

While this analysis established correlation, further research should explore causal mechanisms. Interviews could provide insights into how strengthening technology-content knowledge subsequently motivates and equips educators to explore fuller technology integrations encompassing pedagogy and content. Additional models may also elaborate the relationships between TPACK domains and their development.

In summary, these results statistically validate the intrinsic intersections between teachers' technology, content and pedagogy knowledge bases. Strategic development of technology-content skills reveals cascading potential to enrich holistic TPACK and digitally-enhanced teaching capabilities.

5 Discussion and Implication

This robust, large-scale comparative investigation provides vital empirical insights into technology integration competencies among Taiwanese humanities and social science educators based on analysis of authentic course designs. Our findings reveal potential discipline-specific strengths, weaknesses and opportunities to enhance TPACK abilities in order to bridge the digital pedagogy divide.

The prevalence of PK and TPCK indicates both humanities and social science instructors recognize the importance of situating technology use within pedagogical and content contexts during instructional planning. However, gaps in TK and TPK integration suggest learning to effectively leverage new discrete technologies remains a challenge without focused skills training. TPACK development frameworks emphasize the need to move beyond just acquiring technical skills to situated application within teaching practice [13].

The variance in TC vs TP emphasis also demonstrates different orientations - a pedagogy-content focus among humanities educators compared to a technology-pedagogy emphasis in social sciences [11, 31]. As scholars explain, humanities teachers tend to view technology as merely an "add-on" rather than integral to reshaping pedagogy [31]. Strengthening TPK and TC connections could help shift this mindset towards more embedded, integrative usage of digital tools to transform instructional practices within specific content areas [23].

The differences in technology integration examples also underscore the need to align training with discipline-specific goals and contexts. For humanities, priorities include enhancing digital storytelling, multimedia production, and digital exhibit capabilities [32, 33], which allow connection of technology usage to humanities' focus on narrative, communication and cultural heritage. Meanwhile, social sciences integration of computational tools for analytics, visualization and modeling reflects field-specific aims of understanding patterns, systems thinking and modeling social phenomena [34, 35]. Our findings provide guidance for developing tailored professional development programs that situate training within teachers' own academic domains. This contextualization helps concretize abstract TPACK principles, addressing scholars' critique that generalized technology workshops often remain detached from teachers' actual practices and needs [10, 36].

Furthermore, the knowledge gaps indicate preservice H&SS teacher education may be inadequately preparing educators with sufficient field-relevant TPACK skills [10, 36]. This aligns with findings that "teacher training does not provide enough authentic experiences for teachers to gain TPACK confidence to integrate technology in their specific subjects" [37]. Implementing humanities and social science-specific TPACK models could enable continuous situated development within digital communities of practice [21]. For instance, the TPACK-in-Future approach incorporates supports like video analysis, reflection and planning to deepen technology integration skills [38][40]. More cross-disciplinary collaboration is also needed to strengthen digital literacy across fields [39]. As Swallow and Olofson found, making contextual differences explicit helps teachers see new integration possibilities beyond siloed approaches [39]. H&SS-specific examples from our study could provide stimulus materials to expand educators' TPACK thinking.

Critically, situating training within authentic design tasks appears essential to meaningfully build TPACK. Koh et al. concluded that lesson planning with technology integration substantially increased teachers' self-reported TPACK confidence, unlike stand-alone workshops [40]. Similarly, Tømte et al. determined extensive planning and preparation time enabled higher quality ICT integration [41]. Our findings reinforce the need for sustained, embedded and context-driven TPACK development.

An important direction for future research involves tracking how enhanced TPACK understanding translates to classroom implementation. While this study focused on course planning, few studies have linked educator TPACK to observed technology integration proficiency or associated student outcomes [13, 42]. Longitudinal classroom observations could illuminate how strengthening teachers' design stage TPACK ultimately impacts technology-enabled instruction [42]. Examining student work products and learning gains would also be valuable [43]. Combining planning, process and outcome data could provide a comprehensive perspective on enhancing TPACK's real-world impact.

In terms of limitations, this study exclusively analyzed course syllabi, which may not fully capture enacted TPACK capabilities. Follow-up through interviews, surveys and observations could enrich these findings. Exploring differences across experience levels would also be worthwhile. While this study is situated in Taiwan, TPACK has international relevance for technology integration skills development. Further cross-cultural comparative research could yield additional insights into variances of digital pedagogy integration competencies globally.

6 Conclusion

This study makes an important empirical contribution towards understanding technology integration competencies of humanities and social science educators through comparative examination of TPACK knowledge areas. Our findings highlight potential field-specific strengths, gaps and needs that can inform development of tailored, contextualized efforts to strengthen digital literacy. With concerted cultivation of TPACK abilities aligned to discipline goals, H&SS teachers can become better equipped to provide enriching technology-enhanced learning experiences that help bridge the digital pedagogy divide in the modern classroom.

7 Limitations

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References:

[1] P. DiGregorio and K. Sobel-Lojeski, "The effects of interactive whiteboards (IWBs) on student performance and learning: A literature review," Journal of Educational Technology Systems, vol. 38, no. 3, pp. 255–312, 2010.

[2] L.-Y. Chung and R.-C. Chang, "The effect of gender on motivation and student achievement in digital game-based learning: A case study of a contented-based classroom," Eurasia Journal of Mathematics, Science and Technology Education, vol. 13, no. 6, pp. 2309–2327, 2017.

[3] J. Voogt et al., "Challenges to learning and schooling in the digital networked world of the 21st century," Journal of Computer Assisted Learning, vol. 15, no. 2, pp. 403–413, 2013, doi: 10.1007/s11251-013-9249-6.

[4] G. Abrosimova, I. Kondrateva, E. Voronina, and N. Plotnikova, "Blended learning in university education," Humanities & Social Sciences Reviews, vol. 7, no. 6, pp. 6–10, 2019, doi: 10.18510/hssr.2019.762.

[5] A. Richard, "Effectiveness of ICT integration in Nigerian educational system," Journal of Research in Humanities and Social Science, vol. 9, no. 4, pp. 16–30, 2021.

[6] A. van der Walt, J. Steyn, A. Trusler, and M. van Zaanen, "Challenges and opportunities of digital humanities training in South Africa: Moving beyond the Silos," in Digital research in the arts and humanities, Digital Humanities Workshops: Lessons Learned, L. Estill and J. Guiliano, Eds., London, UK: Routledge, 2023, pp. 55–66.

[7] S. Hardhienata, Y. Suchyadi, and D. Wulandari, "Strengthening technological literacy in junior high school teachers in the industrial revolution era 4.0," Journal of Humanities and Social Studies, vol. 5, no. 3, pp. 330–335, 2021.

[8] R. I. Tursunovich, "Guidelines for designing

effective language teaching materials," American Journal of Research in Humanities and Social Sciences, vol. 7, pp. 65–70, 2022.

[9] T. Abid, G. Zahid, N. Shahid, and M. Bukhari, "Online teaching experience during the Covid-19 in Pakistan: Pedagogy–technology balance and student engagement," Fudan Journal of the Humanities and Social Sciences, vol. 14, no. 3, pp. 367–391, 2021.

[10] S. K. Howard, J. Tondeur, J. Ma, and J. Yang, "What to teach? Strategies for developing digital competency in preservice teacher training," Computers & Education, vol. 165, p. 104149, 2021.

[11] P. Pondee, P. Panjaburee, and N. Srisawasdi, "Preservice science teachers' emerging pedagogy of mobile game integration: a tale of two cohorts improvement study," Research and Practice in Technology Enhanced Learning, vol. 16, no. 1, pp. 1–27, 2021.

[12] T. Trust and J. Whalen, "Emergency remote teaching with technology during the COVID-19 pandemic: using the whole teacher lens to examine educator's experiences and insights," Educational Media International, vol. 58, no. 2, pp. 145–160, 2021.

[13] P. Mishra and M. Koehler, "Technological pedagogical content knowledge: A framework for teacher knowledge," Teachers College Record, vol. 108, no. 6, pp. 1017–1054, 2006.

[14] C. Mouza, "Developing and assessing TPACK among pre-service teachers: A synthesis of research," in Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators, M. C. Herring, M. Koehler, and P. Mishra, Eds., 2nd ed., New York: Routledge, 2016, pp. 169–190.

[15] M. Cahapay, "Navigating the post-COVID-19 era of 'Next Normal' in the context of Philippine higher education," Asia-Pacific Journal of Educational Management Research, pp. 57–64, 2021.

[16] W. Wang, D. Schmidt-Crawford, and Y. Jin, "Preservice teachers' TPACK development: A review of literature," Journal of Digital Learning in Teacher Education, vol. 34, no. 4, pp. 234–258, 2018.

[17] D. Barr, "Embedding technology in translation teaching: Evaluative considerations for courseware integration," Computer Assisted Language Learning, vol. 26, no. 4, pp. 295–320, 2013, doi: 10.1080/09588221.2012.658406.

[18] L. S. Shulman, "Those who understand: Knowledge growth in teaching," Educational Researcher, vol. 15, no. 2, pp. 4–14, 1986.

[19] J. T. Schmidt and M. Tang, "Digitalization in education: Challenges, trends and transformative potential," in Führen und Managen in der digitalen Transformation, M. Harwardt, P. F. Niermann, A. Schmutte, and A. Steuernagel, Eds.: Springer Gabler, Wiesbaden, 2020, pp. 287–312.

[20] C. Angeli and N. Valanides, "Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK)," Computers & Education, vol. 52, no. 1, pp. 154–168, 2009.

[21] C. Angeli, N. Valanides, A. Mavroudi, A. Christodoulou, and K. Georgiou, "Introducing e-TPCK: An adaptive e-learning technology for the development of teachers' technological pedagogical content knowledge," in Technological Pedagogical Content Knowledge: Exploring, Developing, and Assessing TPCK, C. Angeli and N. Valanides, Eds., New York, NY: Springer, 2015, pp. 305–318.

[22] J. G. Martin, "Exploring College Instructors' Integration of Technology into Their Curricula," Doctoral Thesis, College of Education, Walden University, Minneapolis, MN, 2016.

[23] K. Holmes, "Planning to teach with digital tools: Introducing the interactive whiteboard to pre-service secondary mathematics teachers," Australasian Journal of Educational Technology, vol. 25, no. 3, 2009.

[24] M. Koehler, P. Mishra, K. Kereluik, T. S. Shin, and C. Graham, "The technological pedagogical content knowledge framework," in Handbook of Research on Educational Communications and Technology, J. M. Spector, M. D. Merrill, J. Elen, and M. J. Bishop, Eds., New York, NY: Springer, 2014, pp. 101–111.

[25] C. S. Chai, J. H. L. Koh, and C.-C. Tsai, "A review of technological pedagogical content knowledge," Educational Technology & Society, vol. 16, no. 2, pp. 31–51, 2013.

[26] M. Niess, "Transforming Teachers' Knowledge: Learning Trajectories for Advancing Teacher Education for Teaching with Technology," in Technological Pedagogical Content Knowledge: Exploring, Developing, and Assessing TPCK, C. Angeli and N. Valanides, Eds., New York, NY: Springer, 2015, pp. 19–37.

[27] C. S. Chai, J. H. L. Koh, and C.-C. Tsai, "Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK)," Educational Technology & Society, vol. 13, no. 4, pp. 63–73, 2010.
[28] M. Koehler, P. Mishra, and K. Yahya, "Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology," Computers & Education, vol. 49, no. 3, pp. 740–762, 2007.
[29] S. Inpeng and S. Nomnian, "The use of facebook in a TEFL program based on the TPACK framework," Language Education and Acquisition Research Network, vol. 13, no. 2, pp. 369–393, 2020.
[30] C. Mouza, "Learning with laptops," Journal of Research on Technology in Education, vol. 40, no. 4, pp. 447–472, 2008, doi: 10.1080/15391523.2008.10782516.
[31] Gérard, Fabienne, and J. Widener, "A SMARTer way to teach foreign language: The SMART board interactive whiteboard as a language learning tool," San Antonio, Texas, USA, 1999. [Online]. Available: http:// edcompass.smarttech.com/en/learning/ research/SBforeignlanguageclass.pdf
[32] J. Hutson et al., "Artificial intelligence and the disruption of higher education: Strategies for integrations across disciplines," Creative Education, vol. 13, no. 12, pp. 3953–3980, 2022.
[33] J. Wu and D.-T. V. Chen, "A systematic review of educational digital storytelling," Computers & Education, vol. 147, p. 103786, 2020.
[34] F. Siddiq, A. D. Olofsson, J. O. Lindberg, and L. Tomczyk, "What will be the new normal? Digital competence and 21st-century skills: critical and emergent issues in education," (in En;en), Education and Information Technologies, pp. 1–9, 2023.
[35] M.-T. Kaarakainen and L. Saikkonen, "Multilevel analysis of the educational use of technology: Quantity and versatility of digital technology usage in Finnish basic education schools," Journal of Computer Assisted Learning, vol. 37, no. 4, pp. 953–965, 2021.
[36] D. Ifenthaler and D. Gibson, Adoption of data analytics in higher education learning and teaching. Cham, Switzerland: Springer, 2020.
[37] L. Song, "Improving pre-service teachers' self-efficacy on technology integration through service learning," The Canadian Journal of Action Research, vol. 19, no. 1, pp. 22–32, 2018.
[38] J. Tondeur, R. Scherer, F. Siddiq, and E. Baran, "A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap!," Australasian Journal of Educational Technology, vol. 33, no. 3, 2017, doi: 10.14742/ajet.3504.
[39] M. J. C. Swallow and M. W. Olofson, "Contextual Understandings in the TPACK Framework," Journal of Research on Technology in Education, vol. 49, 3-4, pp. 228–244, 2017.
[40] J. H. L. Koh, C. S. Chai, and C.-C. Tsai, "Examining practicing teachers' perceptions of technological pedagogical content knowledge (TPACK) pathways: a structural equation modeling approach," (in En;en), Instructional Science, vol. 41, no. 4, pp. 793–809, 2013, doi: 10.1007/s11251-012-9249-y.
[41] M. Robertson and A. Al-Zahrani, "Self-efficacy and ICT integration into initial teacher education in Saudi Arabia: Matching policy with practice," Australasian Journal of Educational Technology, vol. 28, no. 7, pp. 1136–1151, 2012, doi: 10.14742/ajet.793.
[42] M. C. Herring, M. Koehler, and P. Mishra, Eds., Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators, 2nd ed. New York: Routledge, 2016.
[43] N. Law and L. Liang, "A multilevel framework and method for learning analytics integrated learning design," Journal of Learning Analytics, vol. 7, no. 3, pp. 98–117, 2020.

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