

**PENINGKATAN TPACK GURU SEKOLAH DASAR
MELALUI PENDEKATAN KOLABORATIF-PRAKTIK-REFLEKTIF
DAN DAMPAKNYA TERHADAP PRAKTIK PEMBELAJARAN**

DISERTASI

Diajukan Untuk Memenuhi Salah Satu Syarat Memperoleh
Gelar Doktor Pendidikan Dasar



Oleh
Ai Hayati Rahayu
NIM. 1802714

**PROGRAM STUDI PENDIDIKAN DASAR (S3)
FAKULTAS ILMU PENDIDIKAN
UNIVERSITAS PENDDIKAN INDONESIA
2025**

PENINGKATAN TPACK GURU SEKOLAH DASAR MELALUI PENDEKATAN KOLABORATIF-PRAKTIK-REFLEKTIF DAN DAMPAKNYA TERHADAP PRAKTIK PEMBELAJARAN

Oleh
Ai Hayati Rahayu

S.Si. Universitas Padjadjaran, 1998
M.Pd., Universitas Pendidikan Indonesia, 2014

Sebuah Disertasi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Doktor
Pendidikan (Dr.) pada Fakultas Ilmu Pendidikan

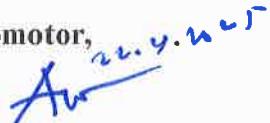
© Ai Hayati Rahayu 2025
Universitas Pendidikan Indonesia
April 2025

Hak Cipta dilindungi undang-undang.
Disertasi ini tidak boleh diperbanyak seluruhnya atau sebagian,
dengan dicetak ulang, difoto kopi, atau cara lainnya tanpa ijin dari penulis.

HALAMAN PENGESAHAN
Ai Hayati Rahayu

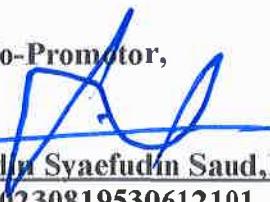
**PENINGKATAN TPACK GURU SEKOLAH DASAR MELALUI
PENDEKATAN KOLABORATIF-PRAKTIK- REFLEKTIF DAN
DAMPAKNYA TERHADAP PRAKTIK PEMBELAJARAN**
Disetujui dan Disahkan oleh panitia disertasi :

Promotor,



Prof. Dr. H. Ari Widodo, M.Ed.
NIP 196705271992031001

Ko-Promotor,

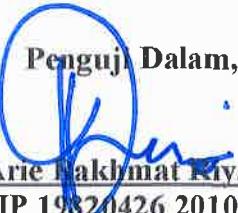


Prof. Dr. H. Udin Syaefudin Saud, Ph.D.
NIPT 920230819530612101

Anggota


Dr. Muslim, M.Pd.
NIP 196406061990031003

Pengaji Dalam,


Dr. Arie Rakhatmat Riyadi, M.Pd.
NIP 19820426 2010121005

Pengaji Luar,



Dr. Yenny Anwar, M.Pd.
NIP 197910142003122002

Mengetahui,

Ketua Program Studi S3 Pendidikan Dasar
Fakultas Ilmu Pendidikan


Dr. Arie Rakhatmat Riyadi, M.Pd.
NIP 19820426 2010121005

ABSTRAK

Penelitian ini bertujuan untuk meningkatkan kompetensi TPACK (*Technological Pedagogical Content Knowledge*) guru sekolah dasar melalui pelatihan dengan pendekatan kolaboratif-praktik-reflektif, serta mengevaluasi dampaknya terhadap praktik pembelajaran di kelas. TPACK merupakan kerangka kerja yang memadukan pengetahuan teknologi, pedagogi, dan konten, yang sangat penting bagi guru dalam menghadapi tantangan pembelajaran di era digital. Pendekatan pelatihan kolaboratif-praktik-reflektif dirancang untuk mendorong keterlibatan aktif guru dalam proses pembelajaran dan meningkatkan kemampuan mereka dalam mengintegrasikan teknologi secara efektif ke dalam pengajaran. Penelitian ini menggunakan metode *mixed-method desain embedded experimental* yang menggabungkan pendekatan kuantitatif dan kualitatif. Data kuantitatif diperoleh melalui *pretest* dan *posttest* untuk mengukur peningkatan TPACK guru sebelum dan setelah pelatihan, sementara data kualitatif dikumpulkan melalui wawancara, observasi, dan refleksi tertulis untuk mendalami pengalaman dan persepsi guru selama pelatihan serta dampaknya pada praktik pembelajaran di kelas. Hasil penelitian menunjukkan bahwa pelatihan dengan pendekatan kolaboratif-praktik-reflektif secara signifikan meningkatkan kompetensi TPACK guru sekolah dasar. Guru yang terlibat dalam pelatihan ini menunjukkan pemahaman yang lebih baik tentang bagaimana mengintegrasikan teknologi ke dalam strategi pengajaran mereka, serta meningkatkan efektivitas dalam merancang dan melaksanakan pembelajaran berbasis teknologi. Selain itu, dampak positif juga terlihat pada hasil belajar siswa di kelas. Kesimpulannya, pelatihan TPACK yang didesain dengan pendekatan kolaboratif-praktik-reflektif tidak hanya berhasil meningkatkan kompetensi guru dalam penggunaan teknologi, tetapi juga berdampak positif pada kualitas pembelajaran di sekolah dasar. Penelitian ini merekomendasikan agar program pelatihan guru di masa depan mempertimbangkan pendekatan-pendekatan ini untuk mencapai hasil yang optimal.

Kata Kunci: TPACK, pelatihan guru, kolaboratif, praktik, reflektif, sekolah dasar, pembelajaran berbasis teknologi

ABSTRACT

This study aims to enhance the Technological Pedagogical Content Knowledge (TPACK) competencies of elementary school teachers through training that incorporates collaborative, practical, and reflective approaches, and to evaluate its impact on classroom teaching practices. TPACK is a framework that integrates technology, pedagogy, and content knowledge, which is essential for teachers to meet the challenges of teaching in the digital age. The training, designed to encourage active teacher involvement and improve their ability to effectively integrate technology into their teaching, utilizes collaborative, practical, and reflective methods. The research employs a mixed-methods approach, combining both quantitative and qualitative methodologies. Quantitative data were collected through pretests and posttests to measure the improvement in teachers' TPACK before and after the training. Qualitative data were gathered through interviews, observations, and written reflections to gain deeper insights into the teachers' experiences and perceptions during the training, as well as its impact on their classroom practices. The results indicate that training with collaborative-practical, and reflective approaches significantly enhances elementary school teachers' TPACK competencies. Teachers involved in the training demonstrated a better understanding of how to integrate technology into their teaching strategies, and increased effectiveness in designing and implementing technology-based learning. Moreover, In addition, positive impacts are also seen in student learning outcomes in class. In conclusion, TPACK training designed with collaborative-practical-reflective approaches not only successfully improves teachers' technology integration competencies but also positively impacts the quality of teaching in elementary schools. This study recommends that future teacher training programs should consider incorporating these approaches to achieve optimal outcomes.

Keywords: TPACK, teacher training, collaborative, practical, reflective, elementary school, technology-based learning.

.

DAFTAR ISI

Isi	Hal
HALAMAN PENGESAHAN	ii
Kata Pengantar	iii
Ucapan Terima kasih	iv
Abstrak	vii
<i>Abstract</i>	viii
Daftar Isi.....	ix
Daftar Tabel	xiii
Daftar Gambar	xv
Daftar lampiran	xvii
 BAB 1 PENDAHULUAN	 1
1.1 Latar Belakang	1
1.2 Rumusan Masalah.....	12
1.3 Tujuan Penelitian	13
1.4 Manfaat Penelitian	13
1.5 Struktur Organisasi	14
 BAB 2 KAJIAN PUSTAKA.....	 16
2.1 <i>Technological Pedagogical Content Knowledge (TPACK)</i>	16
2.1.1 Komponen-Komponen TPACK.....	17
2.1.2 Pengukuran TPACK Guru	27
2.1.3 Faktor-Faktor yang Berpengaruh terhadap TPACK Guru.....	31
2.2. Pelatihan TPACK dengan pendekatan Kolaboratif-Praktik-Reflektif	33
2.2.1 Model-Model Pengembangan TPACK Guru.....	36
2.2.1.1 Pendekatan Kolaboratif.....	46
2.2.1.2 Pendekatan Praktik.....	48
2.2.1.3 Pendekatan Refleksi.....	51
2.2.2 Pelatihan dengan Pendekatan Kolaboratif-Praktik-Reflektif.....	56
2.3 Praktik Pembelajaran Berdasarkan Kerangka TPACK.....	60
2.3.1 Identifikasi dan Analisis Konten Materi	61
2.3.2 Pemilihan Strategi Pembelajaran Terintegrasi Teknologi	65
2.3.3 Merancang Desain Perencanaan Pembelajaran Integratif.....	75
2.3.4. Implementasi Perencanaan dalam Pembelajaran di kelas	78
2.3.5 Evaluasi dan Refleksi.....	80
2.4 Kerangka Pikir Penelitian	82
 BAB III METODOLOGI PENELITIAN.....	 85
3.1 Metode dan Desain Penelitian	85
3.2 Subjek Penelitian.....	87
3.3 Definisi Operasional.....	88
3.4 Tahapan Pelaksanaan Penelitian	90
3.5 Instrumen Penelitian dan Analisis Data	95
3.6 Teknik Analisis Data.....	108

BAB IV HASIL PENELITIAN	112
4.1 Efektifitas Pelatihan dengan Pendekatan Kolaboratif-Praktik-Reflektif terhadap TPACK Guru Sekolah Dasar	112
4.1.1 Profil TPACK Guru Sekolah Dasar Berdasarkan Komponen	114
4.1.2 Domain yang Berpengaruh terhadap TPACK.....	115
4.2 Efektifitas Pelatihan dengan Pendekatan Kolaboratif-Praktik terhadap Kinerja Guru.....	116
4.2.1 Kemampuan Mendesain pembelajaran	117
4.2.2 Kemampuan Praktik Mengajar	125
4.2.3. Hubungan TPACK dengan Kemampuan Praktik Pembelajaran.....	144
4.2.4 Hubungan TPACK Guru terhadap Hasil Belajar Siswa	153
 BAB V PEMBAHASAN	139
5.1 Efektifitas Pelatihan dengan Pendekatan Kolaboratif-Praktik-Reflektif terhadap TPACK Guru Sekolah Dasar	139
5.1.1 Profil TPACK Guru Sekolah Dasar	143
5.1.1.1 <i>Technological Knowledge</i> (TK).....	144
5.1.1.2 <i>Pedagogical Knowledge</i> (PK).....	146
5.1.1.3 <i>Content Knowledge</i> (CK).....	148
5.1.1.4 <i>Pedagogical Content Knowledge</i> (PCK)	150
5.1.1.5 <i>Technological Pedagogicall Knowledge</i> (TPK)	152
5.1.1.6 <i>Technological Content Knowledge</i> (TCK)	154
5.1.2 Domain yang Berpengaruh terhadap TPACK.....	155
5.2 Efektifitas Pelatihan dengan Pendekatan Kolaboratif-Praktik terhadap Kinerja Guru.....	158
5.2.1 Kemampuan Mendesain pembelajaran	159
5.2.2 Kemampuan Praktik Mengajar	171
5.2.3 Hubungan TPACK dengan Kemampuan Praktik Pembelajaran.....	178
5.2.4 Hubungan TPACK Guru terhadap Hasil Belajar Siswa	182
 BAB VI SIMPULAN, IMPLIKASI dan REKOMENDASI.....	189
6.1 Simpulan	189
6.2 Implikasi.....	189
6.3 Rekomendasi	191
 DAFTAR PUSTAKA	193
Lampiran	205

DAFTAR TABEL

Tabel 2.1 Analisis Aktivitas Kolaborasi, Praktik dan Refleksi pada Model Pengembangan TPACK Guru	45
Tabel 2.2 Model Model Refleksi	55
Tabel 2.3 Hasil Penelitian Pengembangan TPACK Menggunakan Pendekatan Kolaborasi, Praktik dan Reflektif	58
Tabel 2.4 Indikator Berpikir Kreatif	72
Tabel 3.1 Data Peserta pelatihan	87
Tabel 3.2 Pelaksanaan Pelatihan Kelompok Eksperimen dan Kontrol.....	91
Tabel 3.3 Perbedaan perlakuan kelompok Eksperimen dengan Kontrol	94
Tabel 3.4 Pengkategorian TPACK.....	95
Tabel 3.5 Kisi-Kisi instrumen Kuisioner TPACK	96
Tabel 3.6 Hasil Uji Validasi Kuisioner TPACK	99
Tabel 3.7 Hasil Uji Reliabilitas.....	100
Tabel 3.8 Hasil Uji Kesepakatan Dua Penilai	104
Tabel 3.9 Interpretasi Nilai Cohen,s Kappa	104
Tabel 3.10 Instrumen dan Analisis data Berdasarkan pertanyaan penelitian.	109
Tabel 4.1 TPACK Guru Sekolah Dasar Berdasarkan Data Kuisioner.....	112
Tabel 4.2 Hasil Uji T Domain TPACK	113
Tabel 4.3 Hasil Analisis Jalur TPACK Guru Sekolah Dasar.....	116
Tabel 4.4 Data Analisis RPP Guru Sekolah Dasar	117
Tabel 4.5 Resume Hasil Analisis RPP Kelompok Eksperimen	118
Tabel 4.6 Resume Hasil Analisis RPP kelompok Kontrol.....	121
Tabel 4.7 Hasil Observasi Praktik Mengajar Guru Sekolah Dasar	125
Tabel 4.8 Hasil Analisis Kemampuan Praktik Mengajar.....	126
Tabel 4.9 Hasil Uji Korelasi TPACK Guru dengan Praktik Pembelajaran ...	129
Tabel 4.10 Hasil Uji Regresi berganda	130
Tabel 4.11 Perbandingan TPACK Mendesain RPP dan Praktik Mengajar ...	133
Tabel 4.12 Data Skor TPACK Guru dan Rata-rata Posstes Hasil Belajar	138
Tabel 4.13 Uji Korelasi TPACK Guru dan Hasil Belajar Siswa	140
Tabel 5.1 Analisis Perubahan TPACK dalam Merancang RPP.....	168
Tabel 5.2 Analisis Kemampuan Mengajar Berdasarkan TPACK.....	175
Tabel 5.3 Perbandingan TPACK, Merancang RPP dan Praktik Mengajar.....	179

DAFTAR GAMBAR

Gambar 2.1 Kerangka TPACK (Koehler dkk., 2013)	17
Gambar 2.2 Tahapan Proses Penalaran dan Tindakan Pedagogi Guru	23
Gambar 2.3 Tahapan Model TPACK-COIR (Jang & Chen, 2010)	39
Gambar 2.4 Model Pengembangan TPACK-COPR (Jang & Chen 2010)	41
Gambar 2.5 Model Pengembangan TPACK-IDDIRR (Lee & Kim, 2014).....	43
Gambar 2.6 Forrest Plot Hasil Metaanalisis Pelatihan Kolaboratif dengan TPACK.....	58
Gambar 2.7 Kerangka Pikir penelitian.....	84
Gambar 3.1 Rancangan Penelitian <i>mix method dengan embedded experimental design</i>	86
Gambar 4.1 Profil TPACK Guru SD Berdasarkan Komponennya.....	114
Gambar 4.2 Hasil Analisis RPP Berdasarkan Komponennya.....	124
Gambar 5.1 Skor Rata-rata TK Kelompok Eksperimen dan Kontrol	144
Gambar 5.2 Skor Rata-rata PK Kelompok Eksperimen dan Kontrol	146
Gambar 5.3 Skor Rata-rata CK Kelompok Eksperimen dan Kontrol.....	148
Gambar 5.4 Skor Rata-rata PCK Kelompok Eksperimen dan Kontrol.....	150
Gambar 5.5 Skor Rata-rata TPK Kelompok Eksperimen dan Kontrol	152
Gambar 5.6 Skor Rata-rata TCK Kelompok Eksperimen dan Kontrol	154
Gambar 5.7 Model Hasil Analisis PLS-SEM	157
Gambar 5.8 Resume Hasil Analisis RPP Komponen Tujuan	161
Gambar 5.9 Resume Hasil Analisis RPP Komponen Materi dan Media.....	164
Gambar 5.10 Resume Hasil Analisis RPP Komponen Model/Metode.....	167
Gambar 5.11 Presentase Komponen Penilaian Kompetensi Abad 21	183

DAFTAR LAMPIRAN

Lampiran 3.1 Bahan Pelatihan Rancangan Materi dan Modul	205
Lampiran 3.2 Rundown Acara Pelatihan	221
Lampiran 3.3 Instrumen Kuisisioner TPACK dan Proses Validasi.....	221
Lampiran 3.4 Tabel Instrumen CoRes	312
Lampiran 3.5 Instrumen Analisis RPP	351
Lampiran 3.6 Lembar Observasi Mengajar Guru	373
Lampiran 3.7 Pedoman Wawancara	390
Lampiran 3.8 Pedoman Pertanyaan pengarah untuk Jurnal Refleksi.....	405
Lampiran 4.1 Deskripsi Hasil Analisis RPP	407
Lampiran 4.2 Deskripsi Hasil Analisi Kemampuan Praktik Mengajar.....	429

DAFTAR PUSTAKA

- Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education*, 43(4), 281–300. <https://doi.org/10.1080/15391523.2011.10782573>
- Abdurahman. (2013). *Identifikasi Pedagogical Content Knowledge Calon Guru Fisika Melalui Pembelajaran Berbasis Multirepresentasi*. 2, 88–97.
- Adji, S. S., Kismiati, D. A., & Safitri, H. (2022). Pelatihan Technological Pedagogical Content Knowledge (TPACK) Sebagai Kerangka Pengetahuan untuk Meningkatkan Kompetensi Guru. *Jurnal Pengabdian UNDIKMA*, 3(3), 401–409. <https://doi.org/https://doi.org/10.33394/jpu.v3i3.5897>
- Agyei, D. D., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology*, 28(4), 547–564. <https://doi.org/10.14742/ajet.827>
- Akbari, R., Behzadpoor, F., & Dadvand, B. (2010). Development of English language teaching reflection inventory. *System*, 38(2), 211–227. <https://doi.org/10.1016/j.system.2010.03.003>
- Aktaş, İ., & Özmen, H. (2020). Investigating the impact of TPACK development course on pre-service science teachers' performances. *Asia Pacific Education Review*, 21(4), 667–682. <https://doi.org/10.1007/s12564-020-09653-x>
- Aktaş, İ., & Özmen, H. (2022). Assessing the performance of Turkish science pre-service teachers in a TPACK-practical course. In *Education and Information Technologies* (Vol. 27, Issue 3). <https://doi.org/10.1007/s10639-021-10757-z>
- Alayyar, G. M., Fisser, P., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service science teachers: Support from: Blended learning. *Australasian Journal of Educational Technology*, 28(8), 1298–1316. <https://doi.org/10.14742/ajet.773>
- Alsofyani, M. M., bin Aris, B., Eynon, R., & Majid, N. A. (2012). A preliminary evaluation of short blended online training workshop for TPACK development using technology acceptance model. *Turkish Online Journal of Educational Technology*, 11(3), 20–32.
- Alsofyani, M. M., & Eynon, R. (2013). A Preliminary Evaluation of a Short Online Training Workshop for TPACK Development. *International Journal of Teaching and Learning in Higher Education*, 25(1), 118–128. <http://www.isetl.org/ijtlhe/>
- Ambaryati. (2019). Profil TPACK Guru SD Negeri Kecamatan Tengaran Kabupaten Semarang Tahun 2018. *Prosiding*, 1–8.
- Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers and Education*, 52(1), 154–168. <https://doi.org/10.1016/j.compedu.2008.07.006>
- Angeli, C., & Valanides, N. (2015). Technological pedagogical content knowledge: Exploring, developing, and assessing tpck. *Technological Pedagogical Content Knowledge: Exploring, Developing, and Assessing TPCK*, 1–331. <https://doi.org/10.1007/978-1-4899-8080-9>
- Anwar, Y., Rustaman, N. Y., Widodo, A., & Redjeki, S. (2016). Perkembangan

- Kemampuan Pedagogical Content Knowledge (Pck) Calon Guru Biologi Pada Pendekatan Konkuren. *Jurnal Cakrawala Pendidikan*, 35(3). <https://doi.org/10.21831/cp.v35i3.8251>
- Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers and Education*, 55(4), 1656–1662. <https://doi.org/10.1016/j.compedu.2010.07.009>
- Ariani, D. N. (2015). Hubungan antara Technological Pedagogical Content Knowledge dengan Technology Integration Self Efficacy Guru Matematika di Sekolah Dasar. *Muallimuna*, 1(1), 79–91. <https://doi.org/10.31602/muallimuna.v1i1.277>
- Arisanti, W. O. L., Sopandi, W., & Widodo, A. (2017). Analisis Penggunaan Konsep Dan Keterampilan Berpikir Kreatif Siswa Sd Melalui Project Based Learning. *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, 8(1), 82. <https://doi.org/10.17509/eh.v8i1.5125>
- Aulia, V., Hakim, L., & Sangka, K. B. (2023). Dampak Tpack Pada Pengembangan Profesionalisme Guru Dalam Praktik Integrasi Teknologi. *Prosiding Simposium Nasional Multidisiplin (Sinamu)*, 4, 235. <https://doi.org/10.31000/sinamu.v4i1.7894>
- Bandung, Y., Nugraha, A. A., Yonathan, B., Langi, A. Z. R., Saptawati, G. A. P., W., D. H., Fany, A., & Liliyansari. (2010). Perancangan sistem produk-layanan Komunitas Guru Belajar untuk Sekolah Dasar di pedesaan. *E-Indonesia Initiative 2010*, 2010(May), 5–8. https://www.researchgate.net/publication/261439197_Perancangan_Sistem_Produk-Layanan_Komunitas_Guru_Belajar_untuk_Sekolah_Dasar_di_Pedesaan
- Baran, E., & Uygun, E. (2016). Putting technological, pedagogical, and content knowledge (TPACK) in action: An integrated TPACK-design-based learning (DBL) approach TeachEdMobile View project Open Pedagogy: Empowering Learners in the Co-Creation of Course Content View project. *Article in Australasian Journal of Educational Technology*, 32(2), 47–63. <https://www.researchgate.net/publication/299594534>
- Bashan, B., & Holsblat, R. (2017). Reflective journals as a research tool: The case of student teachers' development of teamwork. *Cogent Education*, 4(1). <https://doi.org/10.1080/2331186X.2017.1374234>
- Bedwell, W. L., Wildman, J. L., DiazGranados, D., Salazar, M., Kramer, W. S., & Salas, E. (2012). Collaboration at work: An integrative multilevel conceptualization. *Human Resource Management Review*, 22(2), 128–145. <https://doi.org/10.1016/j.hrmr.2011.11.007>
- Berliner, D. C. (2004). Describing the behavior and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology and Society*, 24(3), 200–212. <https://doi.org/10.1177/0270467604265535>
- Bich Dieu, N., Kean Wah, L., & Choon Keong, T. (2019). Understanding Vietnamese Preservice Tefl Teachers' Tpack Development With Design-Based Learning Via Reflective Learning. *International Journal of Education, Psychology and Counseling*, 154–169. <https://doi.org/10.35631/ijepc.4310014>
- Çam, Ş. S., & Erdamar Koç, G. (2021). Technological Pedagogical Content Knowledge Practices in Higher Education: First Impressions of Preservice Teachers. In *Technology, Knowledge and Learning* (Vol. 26, Issue 1). Springer

- Netherlands. <https://doi.org/10.1007/s10758-019-09430-9>
- Cardak, O. (2009). Science students' misconceptions of the water cycle according to their drawings. In *Journal of Applied Sciences* (Vol. 9, Issue 5, pp. 865–873). <https://doi.org/10.3923/jas.2009.865.873>
- Cavanagh, R. F., & Koehler, M. J. (2013). A turn toward specifying validity criteria in the measurement of Technological Pedagogical Content Knowledge (TPACK). *Journal of Research on Technology in Education*, 46(2), 129–148. <https://doi.org/10.1080/15391523.2013.10782616>
- Chai, C. S., Hwee, J., Koh, L., & Tsai, C.-C. (2010). October 2010 Volume 13 Number 4. *Educational Technology & Society*, 13(1), 63–73.
- Chai, C. S., Ling Koh, J. H., Tsai, C. C., & Lee Wee Tan, L. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers and Education*, 57(1), 1184–1193. <https://doi.org/10.1016/j.compedu.2011.01.007>
- Chai, C. S., Ng, E. M. W., Li, W., Hong, H. Y., & Koh, J. H. L. (2013). Validating and modelling technological pedagogical content knowledge framework among asian preservice teachers. *Australasian Journal of Educational Technology*, 29(1), 41–53. <https://doi.org/10.14742/ajet.174>
- Chang, H.-Y., Wang, C.-Y., Lee, M.-H., Wu, H.-K., Liang, J.-C., Lee, S. W.-Y., Chiou, G.-L., Lo, H.-C., Lin, J.-W., Hsu, C.-Y., Wu, Y.-T., Chen, S., Hwang, F.-K., & Tsai, C.-C. (2015). A review of features of technology-supported learning environments based on participants' perceptions. *Computers in Human Behavior*, 53, 223–237. <https://doi.org/https://doi.org/10.1016/j.chb.2015.06.042>
- Charles, B. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching : A review of the literature. *International Journal of Education and Development Using Information and Communication Technology*, 8(1), 136–155.
- Chuang, H.-H., Weng, C.-Y., & Huang, F.-C. (2015). A structure equation model among factors of teachers' technology integration practice and their TPCK. *Computers & Education*, 86, 182–191. <https://doi.org/https://doi.org/10.1016/j.compedu.2015.03.016>
- Crane, M. F., Searle, B. J., Kangas, M., & Nwiran, Y. (2019). How resilience is strengthened by exposure to stressors: the systematic self-reflection model of resilience strengthening. *Anxiety, Stress and Coping*, 32(1), 1–17. <https://doi.org/10.1080/10615806.2018.1506640>
- Dalal, M., Archambault, L., & Shelton, C. (2021). Fostering the growth of TPACK among international teachers of developing nations through a cultural exchange program. *Australasian Journal of Educational Technology*, 37(1), 43–56. <https://doi.org/10.14742/ajet.5964>
- Delgado, A. J., Wardlow, L., McKnight, K., & O'Malley, K. (2015). Educational technology: A review of the integration, resources, and effectiveness of technology in K-12 classrooms. *Journal of Information Technology Education: Research*, 14(2015), 397–416. <https://doi.org/10.28945/2298>
- Dwi, A., Rahayu, P., Nasrudin, H., Kimia, J., Matematika, F., Ilmu, D., & Alam, P. (2014). Penerapan Strategi Konstruktivis Untuk Mereduksi Miskonsepsi Level Sub-Mikroskopik Siswa Pada Materi Kesetimbangan Kimia Kelas Xi Sma

- Hang Tuah 2 Sidoarjo Implementation of Constructivist Strategy To Reduce Student'S Misconception of Sub-Microscopic Level. *Unesa Journal of Chemical Education*, 3(02), 88–98.
- Ennis, R. H. (1987). A taxonomy of critical thinking disposition and abilities. In J. B. Baron & R. J. Sternberg (Eds.), *Teaching thinking skills: Theory and practice*. New York, NY., 9–26.
- Erdogan, A., & Sahin, I. (2010). Relationship between math teacher candidates' Technological Pedagogical And Content Knowledge (TPACK) and achievement levels. *Procedia - Social and Behavioral Sciences*, 2(2), 2707–2711. <https://doi.org/https://doi.org/10.1016/j.sbspro.2010.03.400>
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change. *Journal of Research on Technology in Education*, 42(3), 255–284. <https://doi.org/10.1080/15391523.2010.10782551>
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, 59(2), 423–435. <https://doi.org/10.1016/j.compedu.2012.02.001>
- Fernandez, C. (2014). Knowledge Base for Teaching and Pedagogical Content Knowledge (Pck): Some Useful Models and Implications for Teachers' Training. *Problems of Education in the 21st Century*, 60(1), 79–100. <https://doi.org/10.33225/pec/14.60.79>
- Fullan, M. (2020). Learning and the pandemic: What's next? *Prospects*, 49(1–2), 25–28. <https://doi.org/10.1007/s11125-020-09502-0>
- Gess, J. (2002). Examining Pedagogical Content Knowledge. *Examining Pedagogical Content Knowledge, December*. <https://doi.org/10.1007/0-306-47217-1>
- Gibson, I. W. (2001). At the intersection of technology and pedagogy: Considering styles of learning and teaching. *Journal of Information Technology for Teacher Education*, 10(1–2), 37–62. <https://doi.org/10.1080/14759390100200102>
- Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers and Education*, 57(3), 1953–1960. <https://doi.org/10.1016/j.compedu.2011.04.010>
- Guskey, T. R. (2002). Profesional development and teacher change. *Teachers and Teaching: Theory and Practice*, 8(3), 381–391. <https://doi.org/10.1080/135406002100000512>
- Habibulloh, M., Jatmiko, B., & Widodo, W. (2017). Pengembangan Perangkat Pembelajaran Model Guided Discovery Berbasis Lab Virtual Untuk Mereduksi Miskonsepsi Siswa Smk Topik Efek Fotolistrik. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, 7(1), 27. <https://doi.org/10.26740/jpfa.v7n1.p27-43>
- Harris, J. B., & Hofer, M. J. (2011). Technological pedagogical content knowledge (TPACK) in action: A descriptive study of secondary teachers' curriculum-based, technology-related instructional planning. *Journal of Research on Technology in Education*, 43(3), 211–229. <https://doi.org/10.1080/15391523.2011.10782570>
- Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology

- integration refrained. *Journal of Research on Technology in Education*, 41(4), 393–416. <https://doi.org/10.1080/15391523.2009.10782536>
- Hasanuddin, M. I. (2020). Pengetahuan Awal (Prior Knowledge) : Konsep Dan Implikasi Dalam Pembelajaran. *EDISI : Jurnal Edukasi Dan Sains*, 2(2), 217–232. <https://ejournal.stitpn.ac.id/index.php/edisi>
- Hofer, M., & Grandgenett, N. (2012). TPACK development in teacher education: A longitudinal study of preservice teachers in a secondary M.A.Ed. program. *Journal of Research on Technology in Education*, 45(1), 83–106. <https://doi.org/10.1080/15391523.2012.10782598>
- Jang, S.-J. (2010). Integrating the interactive whiteboard and peer coaching to develop the TPACK of secondary science teachers. *Computers & Education*, 55(4), 1744–1751. <https://doi.org/https://doi.org/10.1016/j.compedu.2010.07.020>
- Jang, S. J., & Chen, K. C. (2010). From PCK to TPACK: Developing a Transformative Model for Pre-Service Science Teachers. *Journal of Science Education and Technology*, 19(6), 553–564. <https://doi.org/10.1007/s10956-010-9222-y>
- Jang, S. J., & Tsai, M. F. (2013). Exploring the TPACK of Taiwanese secondary school science teachers using a new contextualized TPACK model. *Australasian Journal of Educational Technology*, 29(4), 566–580. <https://doi.org/10.14742/ajet.282>
- Janssen, N., Knoef, M., & Lazonder, A. W. (2019). Technological and pedagogical support for pre-service teachers' lesson planning. *Technology, Pedagogy and Education*, 28(1), 115–128. <https://doi.org/10.1080/1475939X.2019.1569554>
- Jason T. Abbott. (2011). An Investigation of the Relationship between Self-Efficacy Beliefs about Technology Integration and Technological Pedagogical Content Knowledge (TPACK) among Preservice Teachers. *Journal of Digital Learning in Teacher Education*, 27(4), 134–143. <https://files.eric.ed.gov/fulltext/EJ936541.pdf>
- Jufri, A. W., Ramdani, A., Gunawan, G., Bachtiar, I., & Wildan, W. (2018). Peningkatan Kompetensi Guru IPA Kota Mataram dalam Memfasilitasi Penggunaan Keterampilan Abad Ke 21 Siswa SMP. *Jurnal Pengabdian Magister Pendidikan IPA*, 1(1). <https://doi.org/10.29303/jpmipi.v1i1.207>
- Juhji, J. (2019). Analyzing Madrasah Ibtidaiyah Teacher Candidates Skill of Technological Pedagogical Content Knowledge on Natural Science Learning. *Al Ibtida: Jurnal Pendidikan Guru MI*, 6(1), 1. <https://doi.org/10.24235/al.ibtida.snj.v6i1.3658>
- Kabakci Yurdakul, I., Odabasi, H. F., Kilicer, K., Coklar, A. N., Birinci, G., & Kurt, A. A. (2012a). The development, validity and reliability of TPACK-deep: A technological pedagogical content knowledge scale. *Computers & Education*, 58(3), 964–977. <https://doi.org/https://doi.org/10.1016/j.compedu.2011.10.012>
- Kabakci Yurdakul, I., Odabasi, H. F., Kilicer, K., Coklar, A. N., Birinci, G., & Kurt, A. A. (2012b). The development, validity and reliability of TPACK-deep: A technological pedagogical content knowledge scale. *Computers and Education*, 58(3), 964–977. <https://doi.org/10.1016/j.compedu.2011.10.012>
- Kafyulilo, A., Fisser, P., Pieters, J., & Voogt, J. (2015). ICT use in science and mathematics teacher education in Tanzania: Developing technological

- pedagogical content knowledge. *Australasian Journal of Educational Technology*, 31(4), 381–399. <https://doi.org/10.14742/ajet.1240>
- Kalk, K., Luik, P., Taimalu, M., & Täht, K. (2014). Validity and reliability of two instruments to measure reflection: A confirmatory study. *Trames*, 18(2), 121–134. <https://doi.org/10.3176/tr.2014.2.02>
- Karaca, F., Can, G., & Yildirim, S. (2013). A path model for technology integration into elementary school settings in Turkey. *Computers and Education*, 68, 353–365. <https://doi.org/10.1016/j.compedu.2013.05.017>
- Karakaya, F., & Yazici, M. (2017). Examination Of Technological Pedagogical Content Knowledge (TPACK) Self-Efficacy For Pre-Service. *European Journal of Education Studies*, 3(3), 252–270. <https://doi.org/10.5281/zenodo.290617>
- Kasi, Y. F., Widodo, A., Samsudin, A., & Riandi, R. (2022). Integrating Local Science and School Science : The Benefits for the Preservation of Local Wisdom and Promoting Students ' Learning. *Research Square*, 1–22.
- Kay, R. (2007). A formative analysis of how preservice teachers learn to use technology: Original article. *Journal of Computer Assisted Learning*, 23(5), 366–383. <https://doi.org/10.1111/j.1365-2729.2007.00222.x>
- Koehler, J. M., Mishra, P., & Cain, W. (2013). What Is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, 193(3), 13–19.
- Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? the development of Technological Pedagogical Content Knowledge. *Journal of Educational Computing Research*, 32(2), 131–152. <https://doi.org/10.2190/0EW7-01WB-BKHL-QDYV>
- Koehler, M. J., Mishra, P., Bouck, E. C., DeSchryver, M., Kereluik, K., Shin, T. S., & Wolf, L. G. (2011). Deep-play: developing TPACK for 21st century teachers. *International Journal of Learning Technology*, 6(2), 146. <https://doi.org/10.1504/ijlt.2011.042646>
- Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, 193(3), 13–19. <https://doi.org/10.1177/002205741319300303>
- Koh, J., & Divaharan, S. (2011). Developing pre-service teachers' technology integration expertise through the TPACK-developing instructional model. *Journal of Educational Computing Research*, 44(1), 35–58. <https://doi.org/10.2190/EC.44.1.c>
- Koh, J. H. L., & Chai, C. S. (2015). *Towards a Web 2.0 TPACK Lesson Design Framework: Applications of a Web 2.0 TPACK Survey of Singapore Preservice Teachers*. 161–180. https://doi.org/10.1007/978-981-287-326-2_11
- Koh, J. H. L., Chai, C. S., & Lim, W. Y. (2017). Teacher Professional Development for TPACK-21CL: Effects on Teacher ICT Integration and Student Outcomes. *Journal of Educational Computing Research*, 55(2), 172–196. <https://doi.org/10.1177/0735633116656848>
- Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2013). Demographic factors, TPACK Constructs, and teachers' perceptions of constructivist-Oriented TPACK. *Educational Technology and Society*, 17(1), 185–196.
- Koh, J. H. L., Woo, H. L., & Lim, W. Y. (2013). Understanding the relationship between Singapore preservice teachers' ICT course experiences and

- technological pedagogical content knowledge (TPACK) through ICT course evaluation. *Educational Assessment, Evaluation and Accountability*, 25(4), 321–339. <https://doi.org/10.1007/s11092-013-9165-y>
- Kopcha, T. J., Ottenbreit-Leftwich, A., Jung, J., & Baser, D. (2014). Examining the TPACK framework through the convergent and discriminant validity of two measures. *Computers & Education*, 78, 87–96. <https://doi.org/https://doi.org/10.1016/j.compedu.2014.05.003>
- Korthagen, F., & Vasalos, A. (2005). Levels in reflection: Core reflection as a means to enhance professional growth. *Teachers and Teaching: Theory and Practice*, 11(1), 47–71. <https://doi.org/10.1080/1354060042000337093>
- Larasati, N. I., & Widayasi, N. (2021). Penerapan Media Pembelajaran Berbasis Augmented Reality Terhadap Peningkatan Pemahaman Matematis Siswa Ditinjau Dari Gaya Belajar. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, 7(1), 45–50. <https://jurnal.umj.ac.id/index.php/fbc/article/view/5524>
- Lee, C. J., & Kim, C. M. (2014). An implementation study of a TPACK-based instructional design model in a technology integration course. *Educational Technology Research and Development*, 62(4), 437–460. <https://doi.org/10.1007/s11423-014-9335-8>
- Lehiste, P. (2015). the Impact of a Professional Development Program on in-Service Teachers' Tpack: a Study From Estonia. *Problems of Education in the 21st Century*, 66(1), 18–28. <https://doi.org/10.33225/pec/15.66.18>
- Leinhardt, G., & Greeno, J. G. (1986). The Cognitive Skill of Teaching. *Journal of Educational Psychology*, 78(2), 75–95. <https://doi.org/10.1037/0022-0663.78.2.75>
- Liliyasi, R. R. A. and. (2017). Investigating Pre-Service Science Teachers (PSTs)' Technological Pedagogical Content Knowledge Through Extended Content Representation (CoRe). *Journal of Physics: Conference Series*, 812(012103). <https://doi.org/10.1088/1742-6596/812/1/012103>
- Lu, L., & Lei, J. (2012). Using Live Dual Modeling to Help Preservice Teachers Develop TPACK. *Journal of Digital Learning in Teacher Education*, 29(1), 14–22. <https://doi.org/10.1080/21532974.2012.10784699>
- Marryono Jamun, Y. (2018). Dampak Teknologi Terhadap Pendidikan. *Jurnal Pendidikan Dan Kebudayaan Missio*, 10(1), 1–136.
- Messina, L., & Tabone, S. (2012). Integrating Technology into Instructional Practices Focusing on Teacher Knowledge. *Procedia - Social and Behavioral Sciences*, 46, 1015–1027. <https://doi.org/https://doi.org/10.1016/j.sbspro.2012.05.241>
- Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Integrating Technology in Teacher Knowledge. *Teachers College Record*, 108(6), 1017–1054.
- Mouza, C., Karchmer-Klein, R., Nandakumar, R., Yilmaz Ozden, S., & Hu, L. (2014). Investigating the impact of an integrated approach to the development of preservice teachers' technological pedagogical content knowledge (TPACK). *Computers & Education*, 71, 206–221. <https://doi.org/https://doi.org/10.1016/j.compedu.2013.09.020>
- Mouza, C., Yang, H., Pan, Y. C., Yilmaz Ozden, S., & Pollock, L. (2017). Resetting educational technology coursework for pre-service teachers: A computational

- thinking approach to the development of technological pedagogical content knowledge (TPACK). *Australasian Journal of Educational Technology*, 33(3), 61–76. <https://doi.org/10.14742/ajet.3521>
- Musa, S., Suherman, A. M., Sujarwo, & Nurhayati, S. (2024). Continuous professional growth: A study of educators' commitment to lifelong learning. *Cakrawala Pendidikan*, 43(2), 502–512. <https://doi.org/10.21831/cp.v43i2.66654>
- Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, 21(5), 509–523. <https://doi.org/10.1016/j.tate.2005.03.006>
- Niess, M. L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educational Computing Research*, 44(3), 299–317. <https://doi.org/10.2190/EC.44.3.c>
- Njiku, J., Mutarutinya, V., & Maniraho, J. F. (2021). Building mathematics teachers' tpack through collaborative lesson design activities. *Contemporary Educational Technology*, 13(2), 1–14. <https://doi.org/10.30935/CEDTECH/9686>
- Nofrion, Wijayanto, B., Wilis, R., & Novio, R. (2012). Analisis Technological Pedagogical and Content. *Jurnal Geografi*, 10(2), 105–116.
- Nordin, H., Davis, N., & Ariffin, T. F. T. (2013). A Case Study of Secondary Pre-service Teachers' Technological Pedagogical and Content Knowledge Mastery Level. *Procedia - Social and Behavioral Sciences*, 103, 1–9. <https://doi.org/10.1016/j.sbspro.2013.10.300>
- Nurina, C. I. E., Riandi, R., Widodo, A., & Yulisman, H. (2019). Students' perceptions concerning the learning environment based on biology teachers' TPACK. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 5(3), 367–378. <https://doi.org/10.22219/jpbiv5i3.7819>
- Papanikolaou, K., Gouli, E., & Makri, K. (2014a). Designing Pre-service Teacher Training based on a Combination of TPACK and Communities of Inquiry. *Procedia - Social and Behavioral Sciences*, 116, 3437–3442. <https://doi.org/https://doi.org/10.1016/j.sbspro.2014.01.779>
- Papanikolaou, K., Gouli, E., & Makri, K. (2014b). Designing Pre-service Teacher Training based on a Combination of TPACK and Communities of Inquiry. *Procedia - Social and Behavioral Sciences*, 116, 3437–3442. <https://doi.org/10.1016/j.sbspro.2014.01.779>
- Papanikolaou, K., Makri, K., & Roussos, P. (2017). Learning design as a vehicle for developing TPACK in blended teacher training on technology enhanced learning. *International Journal of Educational Technology in Higher Education*, 14(1). <https://doi.org/10.1186/s41239-017-0072-z>
- Polly, D., Mims, C., Shepherd, C. E., & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (PT3) grants. *Teaching and Teacher Education*, 26(4), 863–870. <https://doi.org/10.1016/j.tate.2009.10.024>
- Pribadi, B. A. (2017). Media dan teknologi dalam Pembelajaran. *Jakarta: Prenadamedia Group*.
- Prihastuti, I., Widodo, A., . L., & . R. (2021). Belajar melalui Video untuk Melatih Keterampilan Berpikir Kritis Guru IPA. *BIOSFER: Jurnal Biologi Dan*

- Pendidikan Biologi*, 6(1). <https://doi.org/10.23969/biosfer.v6i1.4210>
- Prihatin, E. (2021). Manajemen Pelatihan dan Pengembangan. *Bandung: UPI PRESS.*
- Putri, A. R. A., Hidayat, T., & Purwianingsih, W. (2019). Pelatihan Taksonomi Numerik Sebagai Strategi Untuk Meningkatkan Technological Pedagogical Content Knowledge Guru Biologi. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 7(2), 64–78. <https://doi.org/10.24815/jpsi.v7i2.14332>
- Putri, A. R. A., Hidayat, T., & Purwianingsih, W. (2020). Analysis of technological pedagogical content knowledge (TPACK) of biology teachers in classification of living things learning. *Journal of Physics: Conference Series*, 1521(4). <https://doi.org/10.1088/1742-6596/1521/4/042033>
- Rahayu, A., Widodo, A., Syaefudin, U., & Muslim. (2022). Analisis TPACK Mahasiswa PGSD Unsap Sumedang. *Journal of Elementary Education*, 05(01), 30–38.
- Rahman, B. (2014). Refleksi diri dan upaya peningkatan profesionalisme guru sekolah dasar di Provinsi Lampung. *Paedagogia*, 17(1), 1–14. <https://jurnal.uns.ac.id/paedagogia>
- Rahmawati, N. R., Rosida, F. E., & Kholidin, F. I. (2020). Analisis Pembelajaran Daring Saat Pandemi di Madrasah Ibtidaiyah. *Journal of Primary Education*, 1(2), 139–148.
- Reyes, V. C., Reading, C., Doyle, H., & Gregory, S. (2017). Integrating ICT into teacher education programs from a TPACK perspective: Exploring perceptions of university lecturers. *Computers & Education*, 115, 1–19. <https://doi.org/https://doi.org/10.1016/j.compedu.2017.07.009>
- Riandi, Purwianingsih, W., & Hasibuan, K. (2019). Apakah TPACK Guru Biologi Dipengaruhi Budaya Daerah / Lokal ? (Studi tentang peranan budaya daerah / lokal dalam pembentukan TPACK guru biologi SMA). *Seminar Nasional Pendidikan Biologi Dan Saintek (SNPBS) Ke-IV*, 485–492.
- Ritonga, R., Harahap, R., & Adawiyah Lubis, R. (2022). Pelatihan Metode Refleksi Bagi Guru Sekolah Penggerak Dalam Proses Pembelajaran. *SELAPARANG: Jurnal Pengabdian Masyarakat Berkemajuan*, 6(2), 995. <https://doi.org/10.31764/jpmb.v6i2.8666>
- Robi, M., Kusnandar, D., & Sulistianingsih, E. (2017). Penerapan Structural Equation Modeling (SEM) untuk Analisis Kompetensi Alumni. *Buletin Ilmiah Matematika, Statistik Dan Terapannya*, 6(2), 113–120.
- Rochintaniawati, D., Riandi, R., Kestianty, J., Kindy, N., & Rukayadi, Y. (2019). The analysis of biology teachers' technological pedagogical content knowledge development in lesson study in West Java Indonesia. *Jurnal Pendidikan IPA Indonesia*, 8(2), 201–210. <https://doi.org/10.15294/jpii.v8i2.19303>
- Rochintaniawati, D., Widodo, A., Riandi, R., & Herlina, L. (2018). Pedagogical Content Knowledge Depelopment of Science Prospective Teachers in Profesional Practice Program. *Unnes Science Education Journal*, 7(2), 119–128. <https://doi.org/10.15294/usej.v7i2.23291>
- Saengbanchong, V., Wiratchai, N., & Bowarnkitiwong, S. (2014). Validating the Technological Pedagogical Content Knowledge Appropriate for Instructing Students (TPACK-S) of Pre-service Teachers. *Procedia - Social and*

- Behavioral Sciences*, 116, 524–530.
<https://doi.org/10.1016/j.sbspro.2014.01.252>
- Sahin, I. (2011). Development of survey of technological pedagogical and content knowledge (TPACK). *Turkish Online Journal of Educational Technology*, 10(1), 97–105.
- Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education*, 42(2), 123–149.
- Shulman, L. S. (1986a). Pengertian PCK. 15(2), 12.
<https://pdfs.semanticscholar.org/f29d/a5d8c806102b060e7669f67b5f9a55d8f7c4.pdf>
- Shulman, L. S. (1986b). Those Who Understand Knowledge. *Educational Researcher*, 15(2), 4–14.
- Silalahi, P. (2015). Pengembangan Model Pelatihan Pengintegrasian Teknologi Informasi dan Komunikasi dalam Pembelajaran Matematika bagi Guru SD. *JTP - Jurnal Teknologi Pendidikan*, 17(1), 1–14.
<http://journal.unj.ac.id/unj/index.php/jtp/article/view/5388>
- Sintawati, M., & Abdurrahman, G. (2020). The effectiveness of blended learning to improve pre-service teacher TPaCK in developing multimedia learning mathematics at elementary school. *Journal of Physics: Conference Series*, 1521(3). <https://doi.org/10.1088/1742-6596/1521/3/032014>
- Sorge, S., Kröger, J., Petersen, S., & Neumann, K. (2019). Structure and development of pre-service physics teachers' professional knowledge. *International Journal of Science Education*, 41(7), 862–889.
<https://doi.org/10.1080/09500693.2017.1346326>
- Sugrah, N. U. (2020). Implementasi teori belajar konstruktivisme dalam pembelajaran sains. *Humanika*, 19(2), 121–138.
<https://doi.org/10.21831/hum.v19i2.29274>
- Sumarto, I., & Arief, M. (2019). Analysis of the Ability of Teacher Technological Pedagogical Content Knowledge (Tpck) in Indonesia in the 21St Century. *3rd International Conference on History Education 2019 ANALYSIS*, 174–180.
- Suphasri, P., & Chinokul, S. (2021). Reflective Practice in Teacher Education: Issues, Challenges, and Considerations. *Pasaa*, 62(December), 236–264.
<https://doi.org/10.58837/chula.pasaa.62.1.9>
- Suryandari, K. C., Rokhmaniyah, R., Wahyudi, W., Chamdani, M., & Joharman, J. (2020). Pendampingan Tpck: Teknologi, Pedagogi Dan Pengetahuan Bagi Peningkatan Kompetensi Guru Sd Di Kecamatan Kebumen. *DEDIKASI: Community Service Reports*, 2(2), 29–38.
<https://doi.org/10.20961/dedikasi.v2i2.45226>
- Tai, S. J. D. (2015). From tpck-in-action workshops to classrooms: Call competency developed and integrated. *Language, Learning and Technology*, 19(1), 139–164.
- Tanak, A. (2020). Designing tpck-based course for preparing student teachers to teach science with technological pedagogical content knowledge. *Kasetsart Journal of Social Sciences*, 41(1), 53–59.
<https://doi.org/10.1016/j.kjss.2018.07.012>

- Tondeur, J., van Braak, J., Siddiq, F., & Scherer, R. (2016). Time for a new approach to prepare future teachers for educational technology use: Its meaning and measurement. *Computers & Education*, 94, 134–150. <https://doi.org/https://doi.org/10.1016/j.compedu.2015.11.009>
- Trust, T., Krutka, D. G., & Carpenter, J. P. (2016). “Together we are better”: Professional learning networks for teachers. *Computers and Education*, 102, 15–34. <https://doi.org/10.1016/j.compedu.2016.06.007>
- Uçar, M. B., Demir, C., & Higde, E. (2014). Exploring the Self-confidence of Preservice Science and Physics Teachers towards Technological Pedagogical Content Knowledge. *Procedia - Social and Behavioral Sciences*, 116, 3381–3384. <https://doi.org/https://doi.org/10.1016/j.sbspro.2014.01.768>
- Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., Lambert, M. C., & Mäkitalo-Siegl, K. (2017). TPACK updated to measure pre-service teachers' twenty-first century skills. *Australasian Journal of Educational Technology*, 33(3), 15–31. <https://doi.org/10.14742/ajet.3518>
- Valtonen, T., Sointu, E., Kukkonen, J., Mäkitalo, K., Hoang, N., Häkkinen, P., Järvelä, S., Näykki, P., Virtanen, A., Pöntinen, S., Kostainen, E., & Tondeur, J. (2019). Examining pre-service teachers' Technological Pedagogical Content Knowledge as evolving knowledge domains: A longitudinal approach. *Journal of Computer Assisted Learning*, 35(4), 491–502. <https://doi.org/10.1111/jcal.12353>
- Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge - A review of the literature. *Journal of Computer Assisted Learning*, 29(2), 109–121. <https://doi.org/10.1111/j.1365-2729.2012.00487.x>
- Voogt, J., Fisser, P., Tondeur, J., & van Braak, J. (2016). Using theoretical perspectives in developing an understanding of TPACK. *Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators: Second Edition*, 33–52. <https://doi.org/10.4324/9781315771328>
- W Susilawati, T. W., & R, A. (2019). Pelatihan Desain Technological Pedagogical, Content Knowledge Pembelajaran Matematis Menuju Pendidik Profesional. *Wikrama Parahita: Jurnal Pengabdian Masyarakat*, 324–346.
- Wang, C.-J. (2019). Facilitating the emotional intelligence development of students: Use of technological pedagogical content knowledge (TPACK). *Journal of Hospitality, Leisure, Sport & Tourism Education*, 25, 100198. <https://doi.org/https://doi.org/10.1016/j.jhlste.2019.100198>
- Wang, W., Schmidt-Crawford, D., & Jin, Y. (2018). Preservice Teachers' TPACK Development: A Review of Literature. *Journal of Digital Learning in Teacher Education*, 34(4), 234–258. <https://doi.org/10.1080/21532974.2018.1498039>
- Wardani, A. K., Suhartono, S., & Rini, T. A. (2022). Analisis Penerapan TPACK dalam Rencana Pelaksanaan Pembelajaran di Sekolah Dasar Negeri. *Jurnal Pembelajaran, Bimbingan, Dan Pengelolaan Pendidikan*, 2(6), 577–592. <https://doi.org/10.17977/um065v2i62022p577-592>
- Widodo, A. (2021). Pembelajaran Ilmu Pengetahuan Alam Dasar-Dasar untuk Praktik. In *UPI Press*.
- Wright, B., & Akgunduz, D. (2018). The relationship between technological pedagogical content knowledge (TPACK) self-efficacy belief levels and the usage of web 2.0 applications of pre-service science teachers. *World Journal*

- on Educational Technology: Current Issues*, 10(1), 52–69.
<https://doi.org/10.18844/wjet.v10i1.3351>
- Wuryaningtyas, E. T., & Setyaningsih, Y. (2020). Urgensi pengembangan TPACK bagi guru bahasa Indonesia. *Bahastra*, 40(2), 134.
<https://doi.org/10.26555/bahastra.v40i2.16898>
- Yeh, Y. F., Lin, T. C., Hsu, Y. S., Wu, H. K., & Hwang, F. K. (2015). Science Teachers' Proficiency Levels and Patterns of TPACK in a Practical Context. *Journal of Science Education and Technology*, 24(1), 78–90.
<https://doi.org/10.1007/s10956-014-9523-7>
- Yulisman, H., Widodo, A., Riandi, & Nurina, C. I. E. (2019). JPBI (Jurnal Pendidikan Biologi Indonesia) M oderated effect of teachers ' attitudes to the contribution of technology competencies on TPACK. *Jpbi*, 5(2), 185–196.
- Yulisman, H., Widodo, A., Riandi, R., & Nurina, C. I. E. (2020). the Contribution of Content, Pedagogy, and Technology on the Formation of Science Teachers' Tpack Ability. *Edusains*, 11(2), 173–185.
<https://doi.org/10.15408/es.v11i2.10700>
- Yuliyanto, E., Hidayah, F. F., Istyastono, E. P., & Wijoyo, Y. (2018). Analisis Refleksi pada Pembelajaran: Review Reasearch. *Seminar Nasional Edusaintek*, 30–36.
<https://jurnal.unimus.ac.id/index.php/psn12012010/article/view/4077>
- Yunita, D., & Wijayanti, A. (2017). Pengaruh Media Video Pembelajaran Terhadap Hasil Belajar Ipa Ditinjau Dari Keaktifan Siswa. *SOSIOHUMANIORA: Jurnal Ilmiah Ilmu Sosial Dan Humaniora*, 3(2), 153–160.
<https://doi.org/10.30738/sosio.v3i2.1614>
- Zhang, W., & Tang, J. (2021). Teachers' TPACK Development: A Review of Literature. *Open Journal of Social Sciences*, 09(07), 367–380.
<https://doi.org/10.4236/jss.2021.97027>