Teacher Professional Development to Train Digital Skills with Technological Pedagogical Content Knowledge (TPACK)

Christophorus Ardi Nugraha[1](*), Dedi Kuswandi[2], Henry Praherdhiono[3]

[1,2,3]Educational Technology, Universitas Negeri Malang, Malang, Indonesia

	Abstract
Received : November 24, 2022 Revised : December 13, 2022 Accepted : December 14, 2022	During the Covid-19 pandemic, the trend of blended learning increased rapidly. The Indonesian government provides various supporting facilities for blended learning, one of them is a learning account. Unfortunately, this surge in demand for and provision of supporting facilities has not been matched by sufficient skills to properly organize online learning. Many teachers do not know how to utilize ICT in learning. The author took the initiative to develop teacher professional development activities to improve digital skills. These activities were developed using the technological Pedagogical Content Knowledge (TPACK) and using the Analyze, Design, Develop, Implement, Evaluate (ADDIE) model. The subjects of prototype development are 23 teachers and staff of the Cor Jesu Malang Campus. The subjects of the effectiveness test are 23 teachers from SMA Cor Jesu Malang. Research was conducted from 12 January 2021 to February 2022. Most of the participants were satisfied and confident they could apply the results of this training. Changes in the mastery of learning/training objectives ranged from 50% to 87%. It indicates that this training is effective. It can be concluded that these activities can be duplicated again with some adjustments. First, this training is suitable for teachers at the K12 level. If it will be used for PAUD/TK teachers, this training needs to be redesigned. Second, it would be much better if the institution where the teacher works provide dedicated hours for professional development which are also counted into teaching/additional teacher hours.

Keywords:	Professional Development, Teacher, Digital Skills, TPACK, Training
(*) Corresponding Author:	ardiishere@gmail.com

INTRODUCTION

Online learning and *blended learning* is the face of future learning (Philipsen et al., 2019; Portillo & Lopez de la Serna, 2020) because of its flexibility and convenience. Its components, such as ability to manage information, media, and technology, are the main components in 21st-century learning (Partnership for 21st Century Learning, 2019).

Online learning has increased in demand during the Covid-19 pandemic (Bacher-Hicks et al., 2021). In Indonesia, the government is increasingly providing various online learning facilities. The Ministry of Education and Culture (Kemdikbud) and the Ministry of Religion (Kemenag) launched learning accounts for teachers and students (Kemdikbud, 2020; KOMINFO, 2020). According to 2020 data, the Ministry of Education and Culture has prepared up to 30 million accounts (Widyanuratikah, 2020).

The Ministry of Education and Culture has developed online learning facilities and services, but the digital readiness of schools has not matched this. Most teachers do not have sufficient skills to organize online learning properly (Fernández-Batanero et al., 2020). Teachers don't know how to integrate and utilize technology in learning (Heitink et al., 2017; Muhaimin et al., 2019). Students, who are often called *digital natives* , do not actually have sufficient skills in using technology (Martín et al., 2020; Valtonen et al., 2011).

Digital readiness is also the problem experienced by teachers at the Cor Jesu Campus. Internal surveys in ICT development activities showed that teachers need assistance. The assistance needed is utilizing technology, information, and communication to create effective and interesting learning. It drives the need to design training to help teachers acquire digital skills. Without proper training, the teachers will suffer technostress (Özgür, 2020).

There are several research design on teacher professional development which focused on specific digital tool or learning strategies with TPACK approach, for example web based learning (Bustamante, 2020), GIS (Oda et al., 2020), and STEM (Chatmaneerungcharoen, 2019). However, there are no research design about professional development on Google Workspace for Education platform.

In this research, the author will describe the development process of teacher professional development activities using the TPACK approach. A practical, interesting, and valid digital training tool based on TPACK and Google Workspace for Education platform will be obtained. This tool can be used for further teacher professional development programs.

METHODS

This research is educational design research. Educational design research is a cycle of developing solutions to solve practical and complex problems in education that also provide a theoretical understanding of one's work (McKenney & Reeves, 2013). This method was chosen because of its suitability with the objectives of this study: to produce digital training tools and test their effectiveness.

The subjects of this study consisted of two small trial groups: the first trial group is for prototype development and the second trial group is for testing the effectiveness. The subjects for first trial were 23 teachers and staff of the Cor Jesu Malang Campus. The subjects consisted of 5 teachers from SMK, 5 teachers from SMA, 5 teachers from SMP, 3 teachers from SD, 2 teachers from Kindergarten, and 3 staff from the Head Office. The subjects for the second trial were 23 teachers from Cor Jesu Catholic High School.

The first trial for prototype development was conducted from 12 January 2021 to 19 April 2021. The second for effectiveness testing was conducted from 1 December 2021 to 16 December 2021 and February 2022. The research is located at the Cor Jesu Campus, Jl. JA Suprapto 55 Malang, East Java, 65112.

To control the credibility and objectivity of this training, author was conducting intensive study with educational technology experts, Dr. Dedi Kuswandi, M.Pd. and Dr. Henry Praherdhiono, S.Si., M.Pd., to make sure that collected learning resources are suitable with learning goals. Every week, author

also conducted survey to gather participants' feedback about learning process. Author also recorded participants' feedback during face-to-face meeting and in asynchronous session.

Thinking Framework for Training Development

This training uses the TPACK approach, specifically in the Technological Pedagogical Knowledge (TPK) domain. This domain emphasizes the ability of teachers to utilize various technologies in learning contexts (Koehler & Mishra, 2006). TPK focuses on how to overcome obstacles in using digital tools for teaching and learning (Harris, 2016). There are four basic abilities in this domain (Schmid et al., 2020): a) Able to choose technology that supports teaching approaches in learning, b) Able to choose technology that supports student learning processes, c) Able to adjust the use of technology for teaching activities that different, d) Think carefully about how to use technology in the classroom.

This instructional/training media was developed using the ADDIE learning design model: Analyze, Design, Develop, Implement, Evaluate. This model was chosen because it is quite simple and dynamic and can be adapted to various variables in the field (Branch, 2009b). Procedures in ADDIE are always open to adaptation to the paradigm and context in which they are used. This flexibility is needed by the author because the time available for development is very short. The stages in the ADDIE development model can be seen in Table 1.

Table 1. Stages of ADDIE Development (Branch, 2009)

	Analyze	**D**esign	**D**evelop	**I**mplement	**E**valuate
Concept	Identify the probable causes for a performance gap	Verify the desired performances and appropriate testing methods	Generate and validate the learning resources	Prepare the learning environment and engage the students	Assess the quality of the instructional products and processes, both before and after implementation
Common Procedures	1. Validate the performance gap 2. Determine instructional goals 3. Confirm the intended audience 4. Identify required resources 5. Determine potential delivery systems (including cost estimate) 6. Compose a project management plan	7. Conduct a task inventory 8. Compose performance objectives 9. Generate testing strategies 10. Calculate return on investment	11. Generate content 12. Select or develop supporting media 13. Develop guidance for the student 14. Develop guidance for the teacher 15. Conduct formative revisions 16. Conduct a Pilot Test	17. Prepare the teacher 18. Prepare the student	19. Determine evaluation criteria 20. Select evaluation tools 21. Conduct evaluations
	Analysis Summary	*Design Brief*	*Learning Resources*	*Implementation Strategy*	*Evaluation Plan*

Training strategy used in this training is the adaptation of mentoring strategy taken from the *Professional Direct Service Model* (Joyce & Calhoun, 2010). The author acted as a mentor who introduced various digital devices to be used, direct the learning process, provide examples of their use, and provide feedback on the performance results of the trainees.

Development Stages

The first stage of this research is the development of training prototypes. It follows the steps in the ADDIE learning design development model. Process analysis and design are done before the prototype testing. The processes of develop, implementation, and evaluation are conducted in parallel time.

In the analyze stage, the author identifies various possible factors that cause a gap between expected performance and actual performance. This process begins with conducting an internal survey of teachers at the Cor Jesu Campus, determining training objectives, taking an inventory of the various resources needed, to creating a timeline for training development.

In the design stage, the author breaks down the Technological Pedagogical Knowledge (TPK) into training objectives and training items. Details of the TPK domain and training objectives can be seen in **Table 2**.

Table 2. TPK and Instructional Goals

Desired Performance/TPK Domain	Instructional Goals
1. Able to choose technology that supports the teaching approach	1. The teacher can identify the skills needed to integrate technology into learning 2. The teacher can determine how to find the right assistance for the technological problems encountered 3. Teachers can make and share documents digitally using cloud technology
2. Able to choose technology that supports the learning process	1. Teachers can communicate effectively through digital media 2. Teachers can manage schedules effectively using Google Workspace assistance
3. Able to choose technology for different activities	1. Teachers can hold a virtual meeting effectively 2. Teachers can manage the assignments of students in online settings 3. Teachers can measure the development of students 4. Teachers can teach students to find information effectively 5. Teachers can design interactive learning 6. Teachers can manage the video used for learning 7. Teachers can facilitate the work of the group of students
4. Able to determine how technology is used in class	1. Teachers can exemplify digital citizenship to students

In develop stage, the author begins to develop training tools, starting from training guides, videos, to the tasks that must be done. In the implement stage, the author begins to deliver the training. The training is delivered according to the planned schedule. In the last part, the evaluation stage, the author evaluates the training process that has been implemented. There are two forms of evaluation:

weekly evaluation and the motivation survey based on the Quadrant of Motivation (Osman & Warner, 2020) at the end of training. The result of the motivation survey can be interpreted in Figure 1.
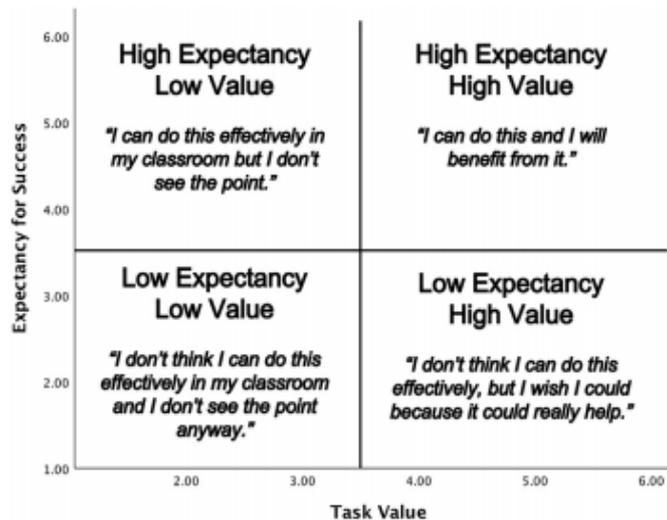

Figure 1. Quadrant of Motivation

RESULTS & DISCUSSION

Result

Data for performance analysis are taken from Transformation Report and internal surveys. The author worked in SMAS Catholic Cor Jesu which uses Google Workspace for Education (GWfE) ecosystem. GWfE provides analytical features that can provide data on the average usage of learning support applications. This analytical feature is called the Transformation Report. From The Transformation Report on November 2020, the use of Google Workspace products is only 35%. On average, only 15 out of 45 teachers use this tool. The product usage is also not evenly distributed. Based on the internal survey, it can be confirmed that participants need assistance on how to utilize digital technology.

There are no special prerequisites for this training. All teachers or staff who are interested in participating in this activity can participate. Participants came from various regions in Malang City and its surroundings. Participants will take part in development activities from their residences due to Large-Scale Social Restrictions (Peraturan Pemerintah Republik Indonesia Nomor 21 Tahun 2020 tentang PSBB, 2020)

Based on the internal surveys, some participants wanted to increase their competence in digital skills. Because there are no prerequisites, it is assumed that the level of ability of the participants is very basic. Participants already use features of Google Workspace for Education, such as Gmail or Google Meet. But for other features, it still needs to be taught from scratch.

Online meetings are held every week using Google Meet. Each session lasts 2 hours. The entire session lasts 4 weeks, with an additional 1 week for participants who need additional time. Thus, the total online meeting is 10 hours. Asynchronous consultation sessions are conducted every day. The author and an assistant provide 2 hours a day, Monday – Friday. The entire session lasts 4 weeks, with an additional 1 week for participants who need additional time. Thus the total consultation time provided is 50 hours. Face-to-face sessions are a special service for participants who really need hands-on guidance. Sessions provided are 4 hours per week. The entire session is expected to last 5 weeks. Thus the total face-to-face session is 20 hours.

In the design stage, the researcher breaks down the training goals into tasks and training items. In develop stage, the author develops training plans and selects instructional media. The first thing author developed is a weekly guide. The weekly guide is an introduction to what will be learned during the week. This guide is given at the beginning of the week, during online meetings. On this occasion, the author will also review the things that need attention from the previous week.

The reference videos are not made from scratch, but use video tutorials from the REFO channel (REFO Indonesia, n.d.) and Applied Digital Skills (Google for Education, n.d.). Videos are selected based on the suitability of the topics discussed each week. Theoretical assignments are reading material that must be completed by the participants. The material for this theoretical assignment is taken from the *Fundamentals Training* provided by Google for Education (Google for Education, 2020). Performance-based assignments given in this training were adapted from the *Skill Checklist for Google Certified Educators* (Eric Curts, 2016).

In the implement stage, the author does not train the trainers because the author also acts as a trainer. The training is held for 4 weeks, starting from 16 January 2021 to 20 February 2021. Every week an online session is held for approximately 2 hours. After that, participants work on individual assignments and asynchronous consultations. Face-to-face meetings were held for participants who really needed direct assistance. The result for implementation stage is described in Table 3.

Table 3. Implementation result

Week	Result
1	In the first week, learning went according to plan. In general, participants were satisfied with the first week's session. Most of the participants have mastered the competencies being taught. However, the submission of individual assignments tends to be overdue. Only a few participants were able to receive suggestions for improvement from the companion.
2	In the second week, the participants' enthusiasm was still relatively the same. From the learning side, obstacles began to emerge. Participants from Head Office could only do assignments while in the office due to limited internet access and laptops in their residences. To solve this, the author holds face-to-face sessions.
3	In the third week, there are several improvement based on the implementation of the training in the previous weeks. First, SD unit also proposed face-to-face sessions. Second, the facilitator added variations to the checklist skills so

	that it was more detailed and could help participants gauge how prepared they were before taking the GCE Level 1 Exam (Google for Education, n.d.-b). Third, participants from the Kindergarten unit began to feel drawbacks to the training rhythm.
4	In the fourth week, the author begins to sort out the readiness of the participants before taking the GCE Level 1 Exam. The author provides extended study time and additional face-to-face sessions for participants who need it. The Kindergarten Unit finally proposed separated training sessions to better suit their needs and pace of learning.

Most of the participants were satisfied and confident they could apply the results of this training. This can be confirmed by the results of the motivation survey at the end of training (Chart 1).
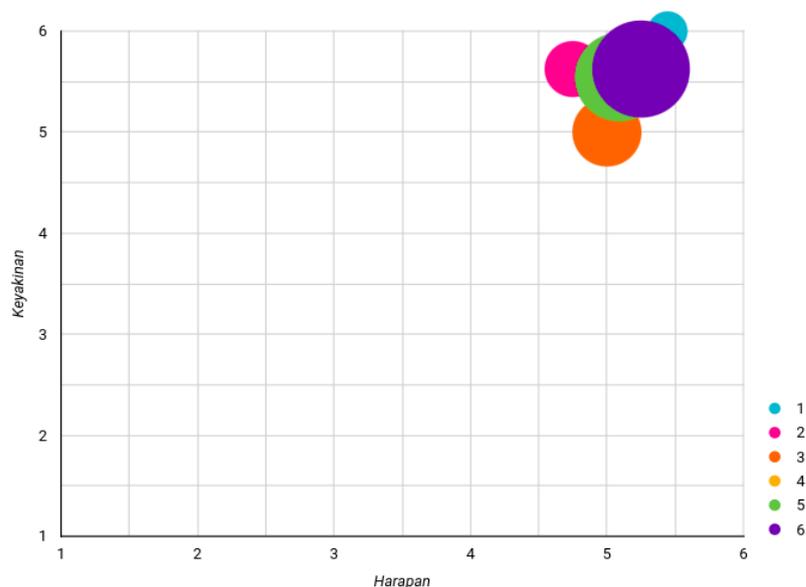

Chart 1. Motivation Evaluation Result

Results in the evaluation stage (Chart 1) show that trainees' motivations are in the High Expectancy - High Value quadrant. It indicates that most participants have high expectations and beliefs about this activity. The varying values of effort indicate that there are differences in the effort required to complete this training. There are participants who require little effort, there are also participants who require a very large effort. For what are the factors that cause the required effort to be small or large, further study is needed.

After developing the training tools, the researchers tested the training tools on teachers at the Cor Jesu Catholic High School in Malang. There are 23 teachers who participated in this training. Unfortunately, due to time and technical constraints, researchers were only able to conduct a pretest and posttest of this training on 8 people. The results of the pretest and posttest were analyzed for interpretation. This method is in accordance with the recommended way of revising the teaching materials (Dick et al., 2014).

Table 4. Effectivity Test Result

Objectives	3		4		5		6		8		9		10		11		12		13	
TEST	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS	PR	PS
DW	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	1
HY	0	1	0	1	1	1	1	1	0	1	0	1	1	1	0	1	0	1	0	1
BL	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
IP	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0
VR	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0
CE	0	1	0	1	0	1	0	1	0	1	0	1	1	1	1	1	0	1	0	1
AR	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
ME	0	0	0	1	0	1	1	1	0	1	0	1	0	1	1	1	0	1	0	1
% Mastering	0	50	0	87.5	12.5	100	25	87.5	12.5	87.5	0	87.5	25	87.5	25	100	0	75	0	75
Difference	50		87.5		87.5		62.5		75		87.5		62.5		75		75		75	

Table 4 shows the difference in mastery between the pretest and posttest. The second row from the bottom shows the percentage of participants who mastered the learning objectives. The results are obtained from the division between participants who successfully answer all exam items in a learning objective correctly by the total number of participants. The bottom row shows the percentage increase from the pretest to the posttest. The results are obtained from the difference in the percentage of mastery between the pretest and posttest.

From these results, it appears that there is a change in mastery between before and after the training. Changes in the mastery of learning/training objectives ranged from 50% to 87%. It indicates that this training is effective.

Discussion

Based on the findings, this training is more suitable for K-12 teachers. Kindergarten teachers tend need more time learning new technology (Gjelaj et al., 2020; Ihmeideh & Al-Maadadi, 2018). Therefore, the training for kindergarten should be designed specifically different from K-12 teachers.

For delivery strategy, teachers tend to prefer face-to-face assistance (Mary Jeanne Olexa Smith, 2021). Face-to-face meetings are preferred because the teacher can directly show the difficulties experienced and the mentor can provide the necessary advice and assistance, and also facilities at school, such as the internet and laptops, are more adequate.

CONCLUSION

With the effectiveness result between 50% - 80%, it can be concluded that these activities can be duplicated again with some adjustments. This training is suitable for teachers at the K12 level. If it will be used for PAUD/TK teachers, this training needs to be redesigned. Although the most of participants are satisfied and confident that they can apply the results of the training to their classroom or workplace, it would be better if the institution where the teacher works provide dedicated hours

for professional development which are also counted into teaching/additional teacher hours. It will be helpful for the teachers because for some teachers, it takes enormous effort to follow and implement the results of this training.

CONFLICT OF INTEREST

Concerning the research, authorship, and publication of this paper, the authors reported no potential conflicts of interest.

REFERENCES

Bacher-Hicks, A., Goodman, J., & Mulhern, C. (2021). Inequality in household adaptation to schooling shocks: Covid-induced online learning engagement in real time. *Journal of Public Economics*, *193*, 104345. https://doi.org/10.1016/j.jpubeco.2020.104345

Branch, R. M. (2009a). Analyze. In R. M. Branch (Ed.), *Instructional Design: The ADDIE Approach* (pp. 22–56). Springer US. https://doi.org/10.1007/978-0-387-09506-6_2

Branch, R. M. (2009b). Prologue. In R. M. Branch (Ed.), *Instructional Design: The ADDIE Approach* (pp. 1–20). Springer US. https://doi.org/10.1007/978-0-387-09506-6_1

Bustamante, C. (2020). TPACK-based professional development on web 2.0 for Spanish teachers: A case study. *Computer Assisted Language Learning*, *33*(4), 327–352. https://doi.org/10.1080/09588221.2018.1564333

Chatmaneerungcharoen, S. (2019). Improving Thai Science Teachers' TPACK through an Innovative Continuing Professional Development Program. *Journal of Physics: Conference Series*, *1340*(1), 012017. https://doi.org/10.1088/1742-6596/1340/1/012017

Dick, W., Carey, L., & Carey, J. O. (2014). *The systematic design of instruction* (Seventh edition). Pearson Education Limited.

Eric Curts. (2016, April 28). *Skill Checklists for Google Certified Educator Level 1 and 2*. https://www.controlaltachieve.com/2016/04/google-educator-checklists.html

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2020). Digital competences for teacher professional development. Systematic review. *European Journal of Teacher Education*, 1–19. https://doi.org/10.1080/02619768.2020.1827389

Gjelaj, M., Buza, K., Shatri, K., & Zabeli, N. (2020). Digital Technologies in Early Childhood: Attitudes and Practices of Parents and Teachers in Kosovo. *International Journal of Instruction*, *13*(1), 165–184. https://eric.ed.gov/?id=EJ1239303

Google for Education. (n.d.). *Google Workspace Training*. Retrieved May 3, 2022, from https://applieddigitalskills.withgoogle.com/c/en/workspace

Google for Education. (2020, August 28). *Fundamentals Training*. Google. https://skillshop.exceedlms.com/student/path/61209-fundamentals-

training?sid_i=0

Harris, J. B. (2016). In-Service Teachers' TPACK Development: Trends, Models, and Trajectories. In *Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators* (pp. 201–216). Routledge. https://doi.org/10.4324/9781315771328-20

Heitink, M., Voogt, J., Fisser, P., Verplanken, L., & Braak, J. van. (2017). Eliciting teachers' technological pedagogical knowledge. *Australasian Journal of Educational Technology*, *33*(3), Article 3. https://doi.org/10.14742/ajet.3505

Ihmeideh, F., & Al-Maadadi, F. (2018). Towards Improving Kindergarten Teachers' Practices Regarding the Integration of ICT into Early Years Settings. *The Asia-Pacific Education Researcher*, *27*(1), 65–78. https://doi.org/10.1007/s40299-017-0366-x

Joyce, B. R., & Calhoun, E. (2010). Personal/Professional Direct Service Models: Helping People Do Their Thing. In *Models of Professional Development: A Celebration of Educators* (pp. 39–60). Corwin Press. https://sk.sagepub.com/books/models-of-professional-development/n5.xml

Kemdikbud. (2020, December 11). *Tingkatkan Akses Layanan Pembelajaran, Kemendikbud Luncurkan Akun Pembelajaran: Belajar.id*. Kementerian Pendidikan Dan Kebudayaan. https://www.kemdikbud.go.id/main/blog/2020/12/tingkatkan-akses-layanan-pembelajaran-kemendikbud-luncurkan-akun-pembelajaran-belajarid

Koehler, M. J., & Mishra, P. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, *108*(6), 1017–1054.

KOMINFO, P. (2020, September 22). *Gandeng Google, Kemenag Luncurkan Transformasi Digital Pendidikan Madrasah*. Website Resmi Kementerian Komunikasi Dan Informatika RI. http:///content/detail/29563/gandeng-google-kemenag-luncurkan-transformasi-digital-pendidikan-madrasah/0/berita

Martín, S. C., González, M. C., & Peñalvo, F. J. G. (2020). Digital competence of early childhood education teachers: Attitude, knowledge and use of ICT. *European Journal of Teacher Education*, *43*(2), 210–223. https://doi.org/10.1080/02619768.2019.1681393

Mary Jeanne Olexa Smith. (2021). *The Impact of Self-Efficacy on Personalized Professional Learning for Google Certification* [Dissertation, Widener University]. http://digitalwolfgram.widener.edu/digital/collection/p16069coll41/id/17161/rec/1

McKenney, S., & Reeves, T. C. (2013). Conducting Educational Design Research. In *Conducting Educational Design Research*. Routledge. https://doi.org/10.4324/9781315105642

Peraturan Pemerintah Republik Indonesia Nomor 21 Tahun 2020 tentang PSBB, (2020). https://jdih.setkab.go.id/PUUdoc/176085/PP_Nomor_21_Tahun_2020.pdf

Muhaimin, M., Habibi, A., Mukminin, A., Saudagar, F., Pratama, R., Wahyuni, S., Sadikin, A., & Indrayana, B. (2019). A sequential explanatory investigation of TPACK: Indonesian science teachers' survey and perspective. *JOTSE*,

9(3), 269–281. https://dialnet.unirioja.es/servlet/articulo?codigo=7637836

Oda, K., Herman, T., & Hasan, A. (2020). Properties and impacts of TPACK-based GIS professional development for in-service teachers. *International Research in Geographical and Environmental Education*, *29*(1), 40–54. https://doi.org/10.1080/10382046.2019.1657675

Osman, D. J., & Warner, J. R. (2020). Measuring teacher motivation: The missing link between professional development and practice. *Teaching and Teacher Education*, *92*, 103064. https://doi.org/10.1016/j.tate.2020.103064

Özgür, H. (2020). Relationships between teachers' technostress, technological pedagogical content knowledge (TPACK), school support and demographic variables: A structural equation modeling. *Computers in Human Behavior*, *112*, 106468. https://doi.org/10.1016/j.chb.2020.106468

Partnership for 21st Century Learning. (2019). *Framework for 21st Century Learning Definitions*. Battelle For Kids. http://static.battelleforkids.org/documents/p21/P21_Framework_Definitions BFK.pdf

Philipsen, B., Tondeur, J., Pareja Roblin, N., Vanslambrouck, S., & Zhu, C. (2019). Improving teacher professional development for online and blended learning: A systematic meta-aggregative review. *Educational Technology Research and Development*, *67*(5), 1145–1174. https://doi.org/10.1007/s11423-019-09645-8

Portillo, J., & Lopez de la Serna, A. (2020). An international perspective for 'Improving teacher professional development for online and blended learning: A systematic meta-aggregative review.' *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-020-09851-9

REFO Indonesia. (n.d.). *REFO Indonesia—YouTube*. Retrieved January 2, 2021, from https://www.youtube.com/c/REFOIndonesia

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK.xs) and comparing the factor structure of an integrative and a transformative model. *Computers & Education*, *157*, 103967. https://doi.org/10.1016/j.compedu.2020.103967

Valtonen, T., Pontinen, S., Kukkonen, J., Dillon, P., Väisänen, P., & Hacklin, S. (2011). Confronting the technological pedagogical knowledge of Finnish Net Generation student teachers. *Technology, Pedagogy and Education*, *20*(1), 3–18. https://doi.org/10.1080/1475939X.2010.534867

Widyanuratikah, I. (2020, December 17). *136 Ribu Akun Sudah Aktif di Laman Belajar.id* [News]. Republika Online. https://republika.co.id/berita/qlhpya463/136-ribu-akun-sudah-aktif-di-laman-embelajaridem