CHEMISTRY ONLINE DISTANCE LEARNING DURING THE COVID-19 OUTBREAK: DO TPACK AND TEACHERS' ATTITUDE MATTER?

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The COVID-19 outbreak has made many countries decide to close schools to prevent the spread, including Indonesia. This leads to online distance learning. Furthermore, online distance learning is carried out by teachers suddenly without prior preparation. Therefore, the teachers' Technological, Pedagogical, Content Knowledge (TPACK), and attitude to conduct online distance learning are crucial. Thus, this study aim to identify chemistry teachers' TPACK, and attitude in online distance learning during the COVID-19 outbreak. Purposed-design study method was used with 109 participants in Java, Indonesia. The data were collected using online questionnaires then analyzed quantitatively using factor analysis and qualitatively based on the teachers' response to online distance learning during the COVID-19. The questionnaire used consisted of 36 close-ended statements with a Likert scale and 10 open-ended questions to find out challenges and opportunities for implementing chemistry online distance learning. The results showed that the teachers tried to adapt their way of teaching and assessment by using various technology platforms for online distance learning. The attitude and TPACK of the teachers tend to be positive in responding to online distance learning even though some senior teachers have a negative tendency to the aspects of attitude and technological knowledge. It can be implied that training in the use of various technologies, and enhancement of chemistry teacher TPACK skills are needed to produce better online distance learning. These results are expected to provide an overview of the challenges and opportunities of online distance learning in chemistry during or beyond the COVID-19 outbreak.

Keywords: COVID-19, Chemistry Online Distance Learning, TPACK, Teacher Attitude

INTRODUCTION

The world, including Indonesia, has been facing Corona Virus Disease 2019 (COVID-19) in recent months. In anticipating the spread of this virus, many countries impose a lockdown status. The lockdown status significantly affects not only the economy but also education (Armitage & Nellums, 2020; Rundle et al., 2020; Viner et al., 2020). Physical distancing and avoiding gathering activities have been enforced to break the chain of this virus (Adnan & Anwar, 2020). The Indonesian government has imposed new policies in education as an impact of preventing the spread of COVID-19. One of the main policies is dismissing face-to-face learning and changing it with online distance learning (Rapanta et al., 2020). Online distance learning is a solution for learning activities during this pandemic, where learning continues following the physical distancing protocol (Basilaia & Kvavadze, 2020; Fuad et al., 2020; Murphy, 2020).

Online distance learning can help to flatten the infection curve and reduce total fatalities from the disease. Before the pandemic, schools in Indonesia, from elementary to high school, still conduct face-to-face learning and rarely implement online distance learning. The reason is partly the lack of facilities and infrastructure for online distance learning (Purwanto et al., 2020). However, the existence of physical distancing rules requires all schools to switch to online distance learning methods to avoid crowds as in the school. Not all education practitioners (teachers, students, and parents) are ready for online distance learning activities, which leads to many problems during the learning process. They will have difficulty in creating effective online distance learning. The condition will impact students' interest during learning because the teacher's attitude, creativity and effectiveness in teaching affect student attitudes, especially in online distance learning (Obermiller et al., 2012).

Teachers' attitudes will influence how they conduct learning, including attitudes towards chemistry learning and technology (Shidiq & Yamtinah, 2019; Yamtinah et al., 2017). Teachers who have negative attitudes transfer their negative perceptions to their students (Shidiq et al., 2020). This effect will increase in science learning such as chemistry which is considered difficult by students (Shidiq et al., 2019). Chemistry is a subject with complex and abstract characteristics that contain theories, concepts, and calculations requiring explanations with chemical representations (Johnstone, 1991; Mahaffy, 2004; Woldeamanuel et al., 2014; Yakmaci-Guzel & Adadan, 2013). In addition, chemistry lessons also require hands-on activities, which are usually carried out with laboratory practicum activities (Shidiq et al., 2021). This practicum activity is needed to create meaningful learning by connecting the theories and concepts of lessons in class with contextual chemistry related to everyday life (Shidiq et al., 2020). The complexity of chemistry makes teachers have to work harder in teaching students through online distance learning. Teachers also need to know and master the various technologies that can be used for online learning. (Phuapan et al., 2016).

Previous studies show that online learning and practicum have a significant effect on student learning outcomes (Cochran et al., 2014), but other studies also show the opposite results; both online learning and practicum give results that are not significantly different (Faulconer et al., 2018). This presents challenges for online learning and practicum.

Researchers have also used various technologies to support the success of online learning. Such as research on an online analytical laboratory project that suggests integrating synchronous and asynchronous instructional modes (Burberger et al., 2020). Other research combines hybrid wet lab and online module lab curriculum into a general chemistry course to improve student performance (Irby et al., 2018) and the use of contextual virtual chemistry labs to support students' online practicum (Davenport et al., 2018).

Teachers can take an online learning and practicum approach specifically to provide the best learning experience for students. This requires technological knowledge so that teachers and students can communicate well in online learning and practicum (Knutsson et al., 2012). Teachers' attitudes towards using technology (ICT) have a significant influence on the implementation of online distance learning (Kisanga, 2016; Prior et al., 2016b; Wasserman & Migdal, 2019). The positive attitude allow them to draw the students' attention and modify the learning content (Tuparova et al., 2006). Through the technological knowledge that teachers have, they can appropriately and efficiently use various digital facilities to identify, integrate, manage, and evaluate meaningful learning needs. (Martin, 2006).

In addition to technological knowledge, teachers are also required to master pedagogical and content knowledge. (Valtonen et al., 2017). Therefore, the ability of teachers to integrate technology, pedagogy, and content in online distance learning is strongly needed (Jimoyiannis, 2010; Matthew J Koehler & Mishra, 2009). The complexity of the integration of these three components is answered through the TPACK (Technological,   Pedagogical,   Content

Knowledge) framework (M. J. Koehler & Mishra, 2005; Matthew J Koehler et al., 2013). Teachers need to master TPACK skills to create meaningful online distance learning and help them in planning and increasing the effectiveness of online distance learning (Stankov & Damyanov, 2017). TPACK is a conceptual framework for the knowledge base teachers need to teach effectively with technology (Koehler & Mishra, 2005). This framework stems from the idea that integrating technology in an educational context will help align technology, pedagogy, and content. Teachers who integrate technology into their teaching practice should consider these three mains (Giannakos et al., 2015a; Harris et al., 2009).

Research on TPACK, and teacher attitude has been carried out. Such as research on TPACK as a framework for understanding technology integration decisions of pre-service teachers (Graham et al., 2012), application of Technological, Pedagogical, and Content Knowledge (TPACK) to develop online writing courses (Tai et al., 2015), understanding the use of technology for pre-service teachers through the TPACK framework (Pamuk, 2012) and teachers' attitudes in online and traditional training courses (Wasserman & Migdal, 2019). Most previous studies focused on teachers and pre-service teachers as research subjects in pre-determined conditions (Giannakos et al., 2015; Koh et al., 2013). Unlike the conditions of the COVID-19 outbreak, online distance learning is carried out by teachers suddenly without prior preparation. Therefore, the chemistry teachers' TPACK, and attitude to conduct online distance learning are crucial. This is the main gap that becomes the focus and novelty of the research. Therefore, this study aims to identify chemistry teachers' TPACK, and attitude to conduct online distance learning during the COVID-19 outbreak. This study focuses on three main problems: how the attitude and TPACK of chemistry teachers are, how chemistry teachers use technology in online distance learning, and what are the challenges and opportunities for implementing chemistry online distance learning. Thus, this study is expected to reveal the possibilities for the implementation of chemistry online distance learning during or beyond the COVID-19 outbreak. In addition, this research is expected to be a reference for chemistry teachers and policymakers to improve chemistry online distance learning.

METHODS

Research Method

A purposed-design survey method was used in this study. The stages of this survey study are identifying the problem, developing research instruments to identify TPACK, and attitude of chemistry teachers, conducting surveys in West Java Province, data analysis and synthesis, and reporting. The data were collected for 1 week at the beginning of June 2020.

Participants

Participants in this study were randomly selected. The questionnaire instrument was distributed online using a Google Form. This questionnaire was distributed to Chemistry teachers at the junior school, high school, and vocational school levels, both public and private, in Java island. A total of 109 Chemistry teachers volunteered to participate in the survey conducted. Participant demographic data are shown in Table 1.

Table 1. Participants Demographic

Demographics variable	N	%	SD
Gender			
Male	37	33.9	25.5
Female	73	66.1	
Education			
BA	69	63.3	
PPG (Teacher Professionalism Training Program)	12	11	29.4
MA	28	25.7	
Teaching experience			
< 5 years	30	27.5	
5-10 years	15	13.8	
10-15 years	12	11	11.5
15-20 years	14	12.8	
< 20 years	38	34.9	
Province of teaching			
DKI Jakarta	5	4.7	
West Java	55	51.4	
Banten	8	7.5	21.3
Central Java	32	29.9	
Yogyakarta	2	1.9	
East Java	5	4.7	
School Level			
Junior High School	2	1.8	
Senior High School	97	89.0	52.7
Vocational High School	10	9.2	
School Status			
Public	63	57.8	12.0
Private	46	42.2	

Data Collection Tools

The instrument or questionnaires used were prepared from the literature and previous research (Prior et al., 2016a; Schmidt et al., 2009; Shulman, 1986, 1987). An example of the questionnaire used is shown in Table 2.

Table 2. Example of the questioner

TPACK	SD	D	U	A	SA
I can teach chemistry subjects by combining chemistry content, technology, and teaching approach.					
I can choose technology to use in my classroom that enhances what I teach, how I teach, and what students learn.					
I can use a strategy that combines technology, teaching approach, and course content that is taught in class.					
I can help other teachers integrate the use of chemistry content, technology, and teaching approaches in my school and/or district.					
I can choose the technology that enhances the chemistry content to be taught.					

A total of 36 statements in the questionnaire with five-scale answer choices from Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (SA) was developed based on the teacher attitude and TPACK indicators. The statements were adapted from the results of the questionnaire development by Schmidt (Schmidt et al., 2014), while ten open-ended questions were used to find out challenges and opportunities for implementing chemistry online distance learning. The questionnaire indicators and correlation of questionnaire indicator used are shown in Table 3.

Table 3. Questionnaire Indicators

Indicators	N of item	Cronbach's Alpha	Communalities	Loading Factor
Attitude	6	.863	.664	.625
Technological Knowledge (TK)	7	.890	.658	.780
Content Knowledge (CK)	3	.740	.672	.818
Pedagogical Knowledge (PK)	7	.881	.872	.823
Pedagogical Content Knowledge (PCK)	2	.730	.866	.699
Technological Content Knowledge (TCK)	1	.874	.708	.787
Technological Pedagogical Knowledge (TPK)	5	.879	.812	.895
Technological Pedagogical Content Knowledge (TPACK)	5	.800	.917	.953

Based on Table 3. The Cronbach's Alpha reliability measurement results for all indicators show more than 0.7; this means that all statements on the indicators have good reliability. In addition, the results of the measurement of loading factors and communalities for all indicators show results that are more than 0.5; this means that the statements

in the questionnaire represent the measured factors. This is reinforced by the results of the correlation test between factors shown in Table 4. Each factor that has a correlation of more than 0.5 shows a strong correlation.

Table 4. Correlation of Questionnaire Indicators

	Attitude	TK	CK	PK	PCK	TCK	TPK	TPCK
Attitude	1	.509	.530	.335	.229	.464	.524	.525
TK		1	.623	.548	.408	.606	.654	.650
CK			1	.651	.497	.571	.666	.689
PK				1	.769	.452	.676	.797
PCK					1	.359	.497	.713
TCK						1	.753	.788
TPK							1	.889
TPCK								1

Data Analysis

The data were analyzed quantitatively and qualitatively. The quantitative data analysis was used to process questionnaire data with SPSS through factor analysis, Pearson correlation for the validity of the instrument, and Alpha Cronbach reliability. The qualitative data analysis was used to process the data about challenges and opportunities for implementing chemistry online distance learning. The qualitative data analysis is extracted based on the open-ended questioner.

RESULTS AND DISCUSSION

Chemistry teachers' attitude and TPACK

The chemistry teachers' attitudes and TPACK toward online distance learning are shown in Figure 1. Of the eight variables measured, content knowledge and

pedagogical knowledge are the variables that have the most positive tendencies. This result indicates that teachers, in general, master chemical content and skills in creating effective teaching and learning environments. Based on the duration of teaching, teachers who have taught for more than five years have much experience to be experts in chemistry teaching

and learning. They know how to manage classes, assess student learning using various methods, and adjust teaching styles to improve instructional practice and student learning (Kleickmann et al., 2012).
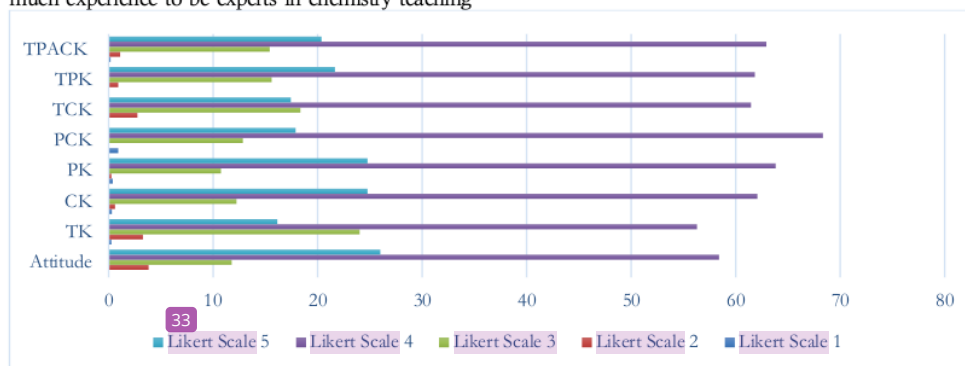

Figure 1. Chemistry teachers' attitude and TPACK toward online distance learning

The results of the questionnaire given to chemistry teachers showed a tendency for a positive attitude towards the use of ICT during chemistry online distance learning. Based on Figure 1, it was found that > 50% of teachers used ICT and found learning more interesting, and there was much potential in the use of technology to enable teachers and students to learn independently. However, data show that some teachers have a negative attitude towards the use of technology in their learning. They are senior teachers who, on average, have more than ten years of teaching experience.

Attitudes towards using ICT have a significant influence on the implementation of online distance learning (Kisanga, 2016; Prior et al., 2016b; Tuparova et al., 2006; Wasserman & Migdal, 2019). Teachers' positive attitude towards using ICT in learning enables them to attract students' attention by developing and using interesting learning materials. Therefore, the positive attitude of teachers towards the use of ICT for chemistry online distance learning is likely to positively influence the way teachers teach and students' learning experiences (Govender & Govender, 2009; Tezci, 2010). Previous studies suggest this may have an impact on two classes of teachers. First, the group of teachers who generally have a younger age will be assumed to have a high ability to use ICT. This type of teacher is referred to as digital natives because they are accustomed to significant exposure to ICT (Ng, 2012). Second, teachers who are generally older will be assumed to have a lower ability to use ICT. This is because older teachers tend to be less exposed to technology, and they are hesitant and unfamiliar with using ICT as their learning medium. (Chu & Chu, 2010). This statement is in line with the results of research showing that older teachers have a negative attitude towards online learning, which requires a lot of technology integration.

Technological knowledge is one factor that can influence innovation in the use of technology by teachers (Schmidt et al., 2009). Knowing the development of technology helps teachers to apply and integrate ICT into learning. Technical skills in the use of technology can help create more efficient and

interesting learning. Although in Figure 1, it is shown, in general, that the teacher has mastered this technological knowledge, some teachers do not understand very well the use of technology in learning.

The technology used by chemistry teachers in online distance learning during the COVID-19 outbreak

The teachers suddenly conducted online distance learning. They had not received training appropriately; even some have not received it at all before. This situation forced them to improvise their teaching practice in online distance learning. They must choose teaching methods that can accommodate all students to present in class in terms of facilities and ease. During this pandemic, teachers implement online distance learning using various technology or learning platform. The technology is mostly used by the teacher presented in Figure 2.
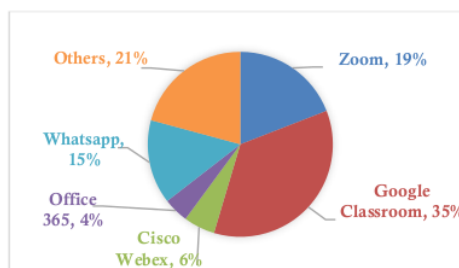

Figure 2. The technology frequently used by chemistry teachers

The learning platform most used by teachers are Google Classroom and Zoom for synchronous learning. The use of short message applications such as WhatsApp also has quite a lot of users. Besides, there are also other applications and technologies that teachers use for learning, such as Quizizz, Kahoot, Schoology, Socrative, Aimsis, Quipper, PhET, Pintro, and ChemOnDro.

In supporting asynchronous chemistry learning, applications, such as Chemondro and PhET, will help

discuss chemistry content and teaching practicum because Chemondro and PhET have chemical content in-game/animation formats. The content can attract and motivate the students to engage more in chemistry classes. However, many teachers are not familiar with the applications and are not accustomed to using them, so that less than five percent of teachers apply them in chemistry learning.

The use of technology can increase the activities of teachers and students to find and obtain learning resources. This activity can be done anytime and anywhere; this is one of the advantages of using technology (McKnight et al., 2016). Based on the teacher's opinion, students' easy access to learning material resources through various platforms allows them to improve and develop a deeper understanding of a lesson topic. Students no longer depend on the information provided by the teacher in the classroom. In addition, with technology, teachers can adjust learning media that can attract students' interest, such as presenting lesson content through YouTube, Facebook, and other platforms. In line with that, the use of social media such as Facebook as a learning medium is proven to have a positive effect on students' academic development (Ainin et al., 2015).

Apart from investigating the use of learning platforms, this study also explores how chemistry teachers do online distance learning. The results are shown in Table 5. In general, they try to integrate technology, such as Google Classroom, in their classrooms to monitor student attendance and social

media, such as YouTube, to share learning videos. In online distance learning, choosing teaching methods and strategies plays a vital role in implementing student learning activities. Holmes et al. highlighted the importance of choosing learning models because they can impact student behavior, graduation rates, and their satisfaction in the course (Holmes et al., 2019). Teacher's creativity and knowledge of technology, content, and pedagogy are essential in making engaging online distance learning for students.

One of the challenges faced in 21st-century learning is preparing young people for citizenship and the global workplace in the global society (Griffin et al., 2012; Trilling & Fadel, 2009). Teachers and students must have communication skills, critical thinking, problem-solving, collaboration, creativity, and innovation (Shidiq & Yamtinah, 2019). Online distance learning does not become a barrier for teachers in teaching these skills to students. Technological pedagogical knowledge is one important factor to be mastered by the teacher in this case. They must utilize technology in developing these skills for students. Table 5 shows the efforts of teachers in developing skills through learning applications to make the lesson not monotonous and prevent boredom. It is tough to control students' understanding and skills in online distance learning. The teacher has tried to provide cases to assist in developing critical-thinking skills through discussion and solving them together, but only intelligent students dominated the activity. The condition makes it difficult for teachers to develop students' knowledge and skills.

Table 5. Online distance learning conducted by teachers

Variable	Teacher's response
How to implement online distance learning	• Providing material and questions using video and Google form and discussing it lives on social media or Zoom • Conducting online learning through Google Classroom and providing a Microsoft 365 link after giving directions to students on WhatsApp • Implementing online learning through the school website where the teacher has uploaded the material and questions
How to teach thinking skills (critical thinking, creativity, problem-solving skills, and others) during online distance learning	• Giving a specific case to students and discussing it on Zoom or other possible media • After uploading the learning video on YouTube and attaching it to Google Classroom, students are asked to leave comments (questions and suggestions) to respond to the learning video. • Through Chemondro, in the game section, there is one task to complete chemical crossword puzzles. There, students can think critically, creatively, and solve problems.
How to teach practical skills during online distance learning	• Making simple demonstration videos or experiments that are shared on the media and asking the students to analyze and review the material or re-do the experiment • Using virtual labs like PhET and providing simple projects to students • Using learning media such as animation, ppt, or Macromedia Flash.
How to assess students' knowledge and skills	• Online exams through learning applications such as Quizi and Kahoot or questions shared in the Google form • Written assignments submitted via email or Edmodo • Assessment can be done from the activities of submitting tasks, discussion or responding to questions, or asking questions

Learning objectives, based on the Minister of Education and Culture of Indonesia Regulation Number 20 of 2016, include the domains of attitude, knowledge, and skills elaborated for each education unit. Skill domain (psychomotor) is a domain related to physical activities such as observing, asking, experimenting, reasoning, presenting, and creating that can be realized in practical activities, especially in the chemistry subject. Lab works are the application of

theories that have been learned in solving problems through experiments. The implementation of lab works needs to be adjusted to learning that is no longer carried out in schools with laboratories (Högström et al., 2010; Mrani et al., 2020; Shidiq et al., 2020b). Based on the teachers' answers, they switched the implementation of lab works in various ways, such as using virtual laboratories, independent lab works, animated videos, and video tutorials made by the teacher. Out of the debate about the significance of online and face-to-face

learning and practicum (Faulconer et al., 2018), there have been examples of research using technology to conduct online practicum. Such as the contextual use 11 virtual laboratories and hybrid wat labs (Buchberger et al., 2020; Davenport et al., 2018; Irby et al., 2018).

Another study changed their practice modules and learning instructions so that students could use them during online practicums (Mahaffey, 2020). Most of these modules use various simple tools that allow students to do practical work at home. This way, indeed, cannot completely replace face-to-face practicum in th 3 aboratory. However, it can be used as an alternative to support professional learning in the case of a 'missing' practicum (Kidd & Murray, 2020). Incorporating these technologies into learning requires TPACK 5 skills.

TPACK emphasizes the connections between technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers' understanding of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies (Harris et al., 2009).

The learning process cannot be separated from the assessment process. A 12 ssment has a vital role in the teaching process. This assessment refers to the wide variety of methods or tools used by teachers to evaluate, measure, and document the academic readiness, learning progress, skill acquisition of students. Appropriate assessments by teachers can be used in classifying and grading their students, giving feedback, and structuring their teaching accordingly (Khlaisang

& Koraneekij, 2019; Koraneekij & Khlaisang, 2019; Tosuncuoglu, 2018). Teachers adapt the assessment method now as they no longer implement face-to-face learning. The assessment techniques carried out vary from using learning applications, assignments sent via email to using attendance and activeness data during discussions in WhatsApp, Zoom, and Google Classroom media. These are done to minimize student cheating. The teacher is worried about their students cheating because they have no direct control so that students can easily copy their friends' works. In this regard, the correct solution is needed, such as creating 51 automatic assessment system of a students' mastery of skill or knowle 15 at a specific time. Slater and Baker highlighted the importance of automatic assessment regarding mastery of skill and knowledge in understanding student learning (Slater & Baker, 2019). They explained how aut 15 tic assessment of student learning could encourage adaptive learning and increase the flexibility of online learning systems to provide a different learning experience.

The challenges and opportunities for implementing chemistry online distance learning

Chemistry online distance learning offers many benefits for teachers as well as students. Nevertheless, that does not mean that this method does not have challenges in its implementation. Table 6 shows the challenges and opportunities experienced by chemistry teachers while implementing chemistry online distance learning during the COVID-19 outbreak.

Table 6. Teacher's response to chemistry online distance learning

Aspect	Teacher's response
Opportunities	▪ This is as suggested by the government to do physical distancing during the COVID-19 pandemic.
	▪ Learning can be done anywhere, anytime, more flexible, time-efficient, and the learning resources used are more diverse.
	▪ It makes students tech-savvy and increases their literacy.
	▪ Material and data on student scores are well stored and can be used at any time.
Challenges	▪ Dependence on the signal, internet, requiring adequate devices, and difficulty for the teacher and the students to exchange ideas
	▪ The teacher cannot control students directly to find out whether they understand and do the assignment.
	▪ Delivery of complex material such as stoichiometry does not run optimally using online distance learning
Suggestions for implementation	▪ There should be a platform that can be accessed by students and teachers (such as websites or applications) that teachers can later develop for the learning process in class according to student needs.
	▪ Teachers should not be required to complete all basic competencies, but there should be mapping to prioritize the basic competencies to be taught. The most crucial orientation is how students can have a valuable and enjoyable learning experience.
	▪ Collaboration among schools, teachers, students, and parents is needed. Parents should fully oversee their children when participating in online learning, teachers should try to provide learning that does not burden students, and schools should provide facilities to facilitate learning.

Based on Table 6, the teachers consider that online distance learning makes teachers and students understand more about technology and increases student literacy because the learning resources used to become more varied (Juanda et al., 2021; Neira et al., 2017). Teachers and students, in general, have not widely used ICT-assisted online learning, so this brings a new atmosphere for education. Besides, online distance learning can help teachers to teach because

they can do it anywhere and anytime. Students have more ample opportunities to understand the material and work on the assignments. In online distance learning, students can access tools or media that will enable them to review the material and interact with others despite the long-distance (Basilaia & Kvavadze, 2020; Jagga 36 2014; O'Malley et al., 2015).

The use of technology in distance learning can increase student activeness in learning because they feel

more confident asking questions about what they do not understand. They do not need to be afraid of being laughed at by their friends and can ask the teacher individually via WhatsApp. This is in line with the previous study stating that collaborative learning with technology such as gamification can affect student activeness in online classes (Huang et al., 2019). They have good interactions with their friends and give feedback to each other. Technology, in this case, can build students' confidence in interacting with their teacher and their friends. Technology also facilitates teachers to recap and archive material files, student data, and other learning files. They can easily access the data because it is stored well in the form of files.

Apart from the opportunities obtained through online distance learning, this method also has challenges. There are challenges encountered during online distance learning by both teachers and students, as shown in Table 6. The implementation of online distance learning is very dependent on the signal and connection of each user. Not all regions in Indonesia have stable signals that make communication not run smoothly. Remote areas that do not yet have a good Internet network have difficulties in implementing this learning method. In addition to the need for an internet signal, teachers and students also need to prepare supporting tools, such as mobile phones, computers, webcams, and other supporting infrastructure, so that online learning can run well (Sadeghi, 2019). This dependence on technology is one of the disadvantages of distance online learning. Technology is crucial for the online learning process; if there is interference with the signal or hardware and software in the technology used, it will disrupt the learning process. In addition, online learning that requires various technologies sometimes limits students and teachers who are not literate towards technology.

Another problem teachers face in online distance learning is that they cannot control students whether they already understand the material and do the assignments. Without face-to-face interaction, the chances of getting distracted and losing track of deadlines are high (Sadeghi, 2019). Students must stay motivated and focused if they want to complete online distance learning material. Online distance learning is not a good idea for students who procrastinate and cannot meet deadlines. Students need someone to motivate them and focus on completing a course successfully (Kör et al., 2016).

In general, online distance learning becomes a solution to continue learning amid this pandemic, but the implementation requires a lot of preparation and evaluation so that the problems can be adequately resolved (Basilaia & Kvavadze, 2020; Murphy, 2020; Myck et al., 2020; Yong, 2020). Some suggestions for the implementation of online distance learning can be seen in Table 6. Teachers' response to the implementation of online distance learning that lasted for approximately 12 weeks is providing a central learning platform that teachers and students can access. The platform can be a reference for teachers in implementing learning so that they are not confused about creating and using technology in learning because the quality of teaching is an essential factor influencing student satisfaction (Sadeghi, 2019).

Previous research on attitudes and TPACK teachers has made scientific contributions in various contexts that have been prepared. This research provides a novelty in teachers' attitudes and TPACK in the context of the COVID-19 pandemic, which forces teachers to conduct online learning without preparation. In addition, as a research contribution, this research presents various views of teachers toward the challenges and opportunities when implementing chemistry online distance learning. This can be used as a reference for other teachers and policymakers to improve the quality of chemistry online distance learning in the future.

CONCLUSION

Online distance learning is a method used by all levels of education in the COVID-19 pandemic to anticipate the spread of the virus. The chemistry teachers responded positively about the implementation of online distance learning in their class viewed from attitudes and TPACK. They improvise in creating interactive classes using various technologies such as social media or chemistry learning applications. There are several cases involving senior teachers where they have difficulty adapting to distance learning. They do not have significant prior exposure to ICT, making them afraid to use ICT in their classrooms. Because distance learning is not limited to time and place, the teaching and assessment process must be adjusted to the lab works using a virtual laboratory and assessment based on student activeness in online discussions. Teachers and students feel the advantages and disadvantages of online distance learning. Drawbacks and problems that arise need to be addressed quickly and precisely.

Recommendations

The recommendation in this study is the need for TPACK training for teachers to familiarize them with integrating technology into their learning. Besides, based on the difficulty of chemistry teachers in teaching hands-on skills, including practicum or laboratory activities, we recommend developing virtual laboratories to help students do simple practicums virtually. Another way can also be to use simple practicum projects that can be done at home to train students' hands-on and creative thinking skills. Another recommendation that is in line with the opinion of the teachers is the need for an integrated online learning system owned by schools to facilitate the online distance learning process.

Limitations of Study

The small number of respondents and the limited area of the survey is the limitations of this study. Increasing the number and types of respondents, such as students, parents, and stakeholders, expanding the scope of the survey area, and using various qualitative and quantitative data collection techniques (not only with questionnaires) for further research will increase the validity of the data obtained for generalization. In addition, the absence of comparative data between chemistry learning that is carried out face to face and online to measure teachers' TPACK skills can be used as a focus for improvement in further research.

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