PROFESSIONAL LEARNING NETWORK ACTIVITIES OF INDONESIAN TEACHERS: DIFFERENTIAL ITEM FUNCTIONING ANALYSIS OF TEACHERS' BACKGROUNDS

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ABSTRACT

Teachers' professional development was gradually shifting to the learning paradigm. Developing a professional learning network (PLN) using social media platforms was one method of teachers' learning. Therefore, this research aimed to investigate the level and differences of activity of teachers when engaged in social media-based PLN using a non-experimental quantitative design. A total of 504 teachers were sampled, and data were collected using PLN Activities Questionnaire (TPLNAQ). Furthermore, the Winsteps application was used to perform the Rasch model analysis. The findings indicated that all teachers sampled had a moderate level of social media-based PLN activities. The demographic factor of qualifications significantly differed between teachers who joined the social media-based PLN. However, some instrument items showed significant differences in responses to the demographic factors of the teachers sampled, namely gender, age, teaching experience, qualifications, and certification.

Keywords: Teachers' networks, online professional learning, social media, teachers' backgrounds.

INTRODUCTION

Professional learning is believed to impact teachers, students, and schools. These positive impacts include a sense of professionalism, commitment to teaching, attitudes toward continuing professional learning, teaching practices, stimulating school change, and improvement in the process and outcomes of student learning (Anderson et al., 2019; Cole, 2012). Yurkofsky et al. showed that teachers who acquire knowledge and skills through professional learning could drive change in their practice and engagement with the outside world (Yurkofsky et al., 2019). Meanwhile, access to broader professional learning helped introduce teachers to new ideas to improve their practice. The implemented learning outcomes are practiced, instilling teachers with confidence and promoting them to approach their profession in novel ways. Along with the development of existing technology, professional learning has shifted toward technological facilities. One popular platform is the use of social media such as Facebook, Twitter, WeChat, Edmodo, Google+, LinkedIn, Edweb, and Schoology, which empirically show a positive impact on various aspects of professionalism and competence (Bommel et al., 2018; Bommel & Liljekvist, 2016; Carpenter & Krutka, 2015; Colwell & Hutchison, 2018; Doak, 2018; Goodyear et al., 2019; Keles, 2018; Nagle, 2018; Prestridge, 2018; Trust et al., 2016; Xue et al., 2019).

A sense of accomplishment in selected career may be fostered by using social media in fields where change occurs rapidly (Mohammed & Kinyo, 2020), such as teaching. Social media is used to build learning networks that focus on teachers' professional development. Social networking sites in the context of professional learning network (PLN) provide opportunities to be active, engage in professional development, and informally manage themselves. PLN is practical and collaborative, promotes independence in developing competencies, and decreases isolation in professional development due to various limitations (Flanigan, 2011; Liljekvist et al., 2017; Trust, 2012). The research by Jones and Dexter showed that interest in PLN is noticeable with the advent of social media in recent years and increased participation in social networking sites such as YouTube, Twitter, and Facebook. This is conducted through involvement in professional learning sites, online video sharing sites, social bookmarking sites, Twitter, podcasts, blogs, and wikis (Jones & Dexter, 2014). In this case, networks can function as a means of expression and communication by professionals, and education has been applied by many teachers' communities (Coutinho & Lisbôa, 2013). Previously, PLN have been conducted using social media. These research explored the social media platform approach for professional learning from the factors of use, forms of activity, and teachers' results (Bissessar, 2014; Bommel et al., 2018; Brown, 2020; Bruguera et al., 2019; Doak, 2018; Goodyear et al., 2019; King, 2017; McLoughlin, 2016; Mostafa, 2020; Nochumson, 2018; Parsons et al., 2019; Trust & Prestridge, 2021).

In the context of PLN using social media platforms, several research showed that it is a potential tool to support professional learning (Patahuddin & Logan, 2019; E. Sari et al., 2012a; E. Sari & Lim, 2012a, 2012b; E. R. Sari, 2012; Sumaryanta et al., 2019). For example, Facebook can provide opportunities to communicate and connect with other educators, allowing relatively easy access to skills, practices, and ways of thinking (Patahuddin & Logan, 2019; E. Sari et al., 2012b). Another research was conducted by Sari & Lim, which specifically explored the complexity of the socio-cultural and contextual aspects through a survey of the Online Learning Community for Teacher Professional Development in Indonesia. Hofstede's cultural dimensions, which consist of the power distance index (PDI), individualism (IDV), uncertainty avoidance (UAI), and masculinity (MAS), were used as a tool for the analysis (E. Sari & Lim, 2012a). Sumaryanta et al. researched professional learning in a community-based teachers' training model and investigated the results after the implementation in Indonesia (Sumaryanta et al., 2019). The results showed that community-based teachers' training had transformed development strategies, which has succeeded in increasing pedagogical and professional competence, motivating individuals to be involved in continuous learning efforts by building a strong network.

As rapidly as information technology and social media infiltrate teachers' life on a vast scale, there is an emergence of informal networks of teachers whose primary focus is professional growth. Social media platforms build learning communities, gather community members, as well as interact and mobilize them in learning activities. Facebook, Instagram, Telegram, WhatsApp, and teleconference applications (Zoom, Webex, Google Meet) are familiar social media. However, no research specifically investigated teacher-learning community members' level of experience or activity. The disposition of the program designer to pay attention to demographic factors can be a determining factor for teachers' participation, hence, the results of teachers' professional development programs can be successful (Loucks-Horsley et al., 2010; Saka, 2013). Another research suggested that in making decisions about professional development programs, two crucial issues require further research, namely the aspects of learning and the effect of teachers' characteristics (Copur-Gencturk & Thacker, 2021). Therefore, it is essential to investigate teachers' level of experience or activity when engaged in social media-based PLN and the demographic factors. The investigation is required to comprehensively understand teachers' activities in the learning community that carries out the process. This research will deepen the focus on how social media-based PLN is used to develop competence and professionalism in teaching. The analysis explores how teachers carry out activities based on the elements in PLN seen from some of their demographic factors.

Based on the background, the following research questions were investigated 1) What was the level of teacher's activities when engaged in social media-based PLN? 2) Are there differences in the level based on their demographic factors? and 3) What teachers' activities differ in the social media-based PLN based on their demographic factors?

THEORETICAL FRAMEWORK

Professional Learning Network

Continuous and quality teachers' professional development becomes an essential and strategic issue in creating high-quality learning (Fraser et al., 2007; Guskey, 2002; Leal Filho et al., 2018; Scott, 2010). Generally, the development programs should be continuously offered to learn and become aware of the main points and principles of professional competence. These include alternatives to develop competence in their teaching practice (Stranovska et al., 2017). The development areas are lesson preparation and planning, teaching and learning, assessment and evaluation, professional development, communication, counselling, classroom management, as well as project and time management to improve the quality of education and teachers' performance (Goksoy, 2018).

Several research showed that teachers' professional development will promote improvement in teaching quality, the achievement of learning objectives, improvement of student learning processes and outcomes, as well as improvement in the effectiveness of schools and educational reforms (Akiba & Liang, 2016; Brooks & Gibson, 2012; Gibson & Brooks, 2013; Helleve, 2010; OECD, 2019; Ozdemir, 2013; Thacker, 2017; UNESCO, 2016). Hamre et al. showed that high-quality professional development programs could improve pedagogical quality (Egert et al., 2020). Furthermore, participation in professional development activities positively relates to teachers' teaching practices in the classroom. Even though the learning practice elements have a tiny effect on expected student performance, participation in professional learning or development activities can make a difference (Fischer et al., 2018). In this era, every teacher is required to develop, achieve different and better results, and be willing to continue learning to achieve self-development as a reaction to their needs and pedagogical reflections. Therefore, professional development gradually shifts to professional learning (Easton, 2008; Grimmett, 2014).

PLN is defined as "a system of interpersonal connections and resources that support informal learning" (Trust, 2012, p. 133). It offers a new space where teachers can learn and grow as professionals with the support of various networks of individuals and resources. With the latest advances in technology and broad access to the internet, teachers can expand their network of connections beyond face-to-face networks, seek emotional help and support, and collect a wealth of professional knowledge. PLN is a broader and multifaceted system that often combines many communities, practice networks, as well as locations supporting online and offline learning.

As previously stated, technology offers innovative ways to overcome time and location constraints (Scott, 2010). Teachers engage with digital technologies to build a PLN, interact and connect with other educators, access and share resources, and collaborate to learn (Hilt, 2015). Digital technology allows engagement in collaborative learning related to pedagogical techniques and best practices. The online community can decrease classroom isolation by promoting collaboration between like-minded teachers in their schools, teachers among schools in all districts and nationally, and even with various individuals worldwide. This extensive interaction broadens the perception of teaching and learning in different contexts. As a comparison, some organizations form PLN by forming multidimensional connections and interactions, comparable to spiders weaving webs. Meanwhile, the networks can promote the relationship between each teacher and the community to collectively improve the quality of school learning (Day, 2004).

Networked learning presumes that learning and understanding result from relational interaction and conversation. Collaboration, participation, and responsibility play a central role in the learning process. PLN promotes interaction through discussions, relying on participants' active participation and responsibility in their professional learning process. In detail, Dirckinck-Holmfeld explained that there are several values in networked learning, namely 1) Cooperation and collaboration in the learning process, 2) Working in groups and communities, 3) Discussion and dialogue, 4) Promoting independence in the learning process, 3) Diversity and teachers' position as the centre of the learning process, 4) Trust and relationships, 5) Reflection and self-investment in networked learning processes, and 6) Technology that acts as a liaison and mediator (Dirckinck-Holmfeld et al., 2012).

Elements of Teachers' Professional Learning Network (PLN) Activities

Krutka et al. identified five critical elements of teachers' PLN activities, namely engaging, discovering, experimenting, reflecting, and sharing (Krutka et al. 2016). Engaging with PLN activities can occur in various ways, for example, on a local level by attending school meetings or regional conferences and connecting with educators globally in affinity spaces. Discovering is conducted by expanding new ideas, learning resources, teaching models, and strategies. This is achieved by connecting with colleagues with various backgrounds and ways of thinking, including ideas and resources. Experimenting refers to the effort and process of reflection on testing new ideas, learning resources, teaching models, and strategies. Therefore, with the involvement in learning activities, teachers can gain the confidence to implement new ideas, teaching methods and strategies, and technology in their classrooms. Reflecting is performed by evaluating the implementation results, the impact on the learning process, and the effect on student learning outcomes. Teachers use sharing as a multidirectional process to disseminate information, knowledge, skills, and resources. This process promotes them to hone and demonstrate their expertise as well as contribute to increasing competence and professionalism in improving students learning processes and outcomes.

Social Media Platform

Social media is a web and mobile-based platform built using Web 2.0 technology. It allows users at the micro, meso, and macro levels to share and geotag user-created content (images, text, audio, video, and

games), as well as collaborate and build networks (Ouirdi et al., 2014). The growth of Web 2.0 services has made the read/write web a reality, allowing people to become creators of online information, produce original content, make comments, mark objects, and mix other people's content. Moreover, it offers excellent opportunities to distribute ideas and creative artefacts worldwide (Ng, 2015). The current information age supports web users to take a new attitude and role when accessing the internet by searching for information, interacting, collaborating, producing, and publishing content (Coutinho & Lisbôa, 2013). The emergence of Web 2.0 sites and social media platforms has facilitated and provided teachers with learning opportunities (Trust et al., 2016).

The rapidly advancing information and communication technology promote the growth and development of various social media platforms, each of which has advantages and disadvantages. Social networking sites allow teachers to engage in professional development practically and collaboratively. These opportunities change teachers' forms and daily experiences to be shared and discussed. The discussions provide a chance to focus on an issue and critically discuss subject-related materials or pedagogical skills. Even though the quality of sharing knowledge on social media varies, the activities show a new dimension and dynamic of teachers' daily experience (Liljekvist et al., 2017).

Teachers' Demographic Factors

SSeveral research showed how teachers' demographics need to be a concern in professional development and learning. An example is the disposition of the program designer to pay attention to demographic factors for a successful teachers' professional development (Loucks-Horsley et al., 2010; Saka, 2013). Another research demonstrated that the consideration of program elements, such as teachers' demographic factors, informs refinement and delivery strategies to reveal specific teaching resources that optimize the benefits received when participating in the program (Downer et al., 2009). Furthermore, in making decisions about professional development programs that lead to teachers' learning, two crucial issues require further research, namely aspects of learning and the effect of demographic factors (Copur-Gencturk & Thacker, 2021). While teachers' professional development is not a one-size-fits-all approach, the results of Powell's research showed that length of teaching experience, expertise, and context, play an essential role in shaping perceptions of experience and participation in online professional development (Powell & Bodur, 2019). Based on the above research, it is crucial to examine teachers' participation in PLN from the point of view of teachers' demographic factors.

METHOD

This research used a non-experimental quantitative design, and the teachers' professional learning network activities questionnaire (TPLNAQ) retrieved the research data.

Participants

AAs many as 504 teachers were sampled in this research. They participated in PLN in three teachers' learning communities, namely Komunitas Guru Belajar Nusantara (Nusantara learning teachers community), Forum Guru IPS (Indonesian social sciences teachers forum), and Sadar IGI (Indonesian teachers association online workshop). These three communities' activities are based on social media such as Facebook, Instagram, Telegram, WhatsApp, and video conferencing. The respondents were from seven island groups and thirty provinces. The participation was conducted anonymously and voluntarily to maintain the ethics of this research. The demographic profile of the respondents is shown in Table 1.

Table 1. Teachers' Demographic Profile

Demographics	f	%
Gender		
Female	318	63.10%
Male	186	36.90%
Age		
21 - 30 years	65	12.90%
31 - 40 years	215	42.66%
41 - 50 years	167	33.13%
51 - 60 years	57	11.31%
Experience		
1 - 10 years	158	31.35%
11 - 20 years	245	48.61%
21 - 30 years	84	16.67%
31 - 40 years	17	3.37%
Qualification		
Postgraduate	118	23.41%
Undergraduate	386	76.59%
Certification		
Passed	343	68.06%
Not yet in	127	25.20%
In process	34	6.75%
Island		
Sumatera, Bangka & Riau Island	79	15.67%
Jawa & Madura	232	46.03%
Bali & Nusa Tenggara	47	9.33%
Kalimantan	43	8.53%
Sulawesi	81	16.07%
Maluku & Maluku Utara	14	2.78%
Papua	8	1.59%

Data Collection and Analysis

The instrument was developed regarding the concept of the five key elements of teachers' PLN experiences by Krutka et al. (2016), namely engaging, discovering, experimenting, reflecting, and sharing (Krutka et al. 2016). The five key elements measure teachers' PLN activities. Furthermore, these indicators were developed into 47 items, consisting of engaging (21 items), discovering (8 items), experimenting (6 items), reflecting (6), and sharing (6). TPLNAQ consists of a four-point Likert-type scale for all items ranging from never (1) to always (4). Respondents filled out online questionnaires through links circulated on social media groups of three teachers' communities, and 504 instruments were filled in before data analysis.

Validity and Reliability of the Instrument

Based on the Summary Statistics Table (Appendix A), 504 respondents gave complete responses to 47 items. Measured Person data showed that MNSQ infit (1.01) and outfit (1.00) were not different from the expected value of 1.00. Therefore, the pattern of answers on the instrument was good. The value of ZSTD

infit (-0.3) and outfit (-0.3), compared to the expectation value of 0.0, showed that the overall pattern had conformity to the model. The data showed that the reliability was 0.95. Based on the criteria rating table of scale instrument quality by William P. Fisher Jr. (Rasch.org, 2018; Sumintono & Widhiarso, 2015), the reliability is classified as excellent. This indicates that the scale discriminated very well between respondents.

Based on the Summary Statistics Table (Appendix A), TPLNAQ results could also be seen on each item. The measured item showed data the MNSQ infit and outfit were not different from the expected value of 1.00. Likewise, when the value of ZSTD infit and outfit is compared to the expectation value of 0.0, the overall item was good and had conformity to the model. The data also showed the reliability of items 0.99 and was classified as excellent according to the criteria rating table of scale instrument quality by William P. Fisher Jr. (Rasch.org, 2018; Sumintono & Widhiarso, 2015). Therefore, the probability of respondents responding to items was high, and the items defined the latent variable very well (Bond & Fox, 2015).

The interaction between 504 respondents and 47 items was described in the Rasch Model calculation through the Cronbach Alpha coefficient. Data showed a value of 0.96 (Appendix A), classified as excellent according to the criteria rating table of scale instrument quality by William P. Fisher Jr. (Rasch.org, 2018; Sumintono & Widhiarso, 2015). This score indicated a high level of interaction between respondents and items, and an instrument with excellent psychometric internal consistency is considered very reliable.

Person and Item Separation Index

PPredictions of how well an instrument can distinguish between respondents' abilities in terms of latency can be shown by the Person Separation index. The greater the separation index, the more likely the respondent will respond to items correctly. On the contrary, the item separation index will show the wide distribution in defining easy and difficult items (Boone et al., 2014). The criterion is that the wider the separation, the more appropriate the spread has to be equal to or more than three (Rasch.org, 2018; Sumintono & Widhiarso, 2015). Based on research data, the Person (4.24) and the Item Separation index (11.18) in the Summary Statistics Table (Appendix A) showed a good spread of TPLNAQ across the range of respondents and items. Therefore, TPLNAQ is appropriate and reliable for identifying teachers' PLN activities' levels.

Unidimensionality Measurement

Predictions of how the instrument calculates what should be measured can be shown by Standardized Residual Variance (Appendix B). The table shows that TPLNAQ has raw and unexplained variance explained by a measure of 45.3% and 8.8%. Based on the criteria rating table of scale instrument quality by William P. Fisher Jr., the minimum requirement for raw variance explained by measure is 20%. Furthermore, when the value is more than 40%, the unexplained variance should ideally not exceed 15% (Rasch.org, 2018; Sumintono & Widhiarso, 2015).TPLNAQ has a good unidimensionality measurement, which means it is considered good in calculating what should be measured. In other words, TPLNAQ effectively measures teachers' PLN activities' levels.

Rating Scale Analysis

Rating Scale Analysis (Appendix C) can be used to verify the ranking of the options used. The table shows that the observed average starts from logit -1.34, -0.32, 0.89, and 2.05 for responses with a score of 1, 2, 3, and 4, with an increase in logit value from option 1 to 4. As a result, there was a monotonic increase, meaning the measurement occurred well. The absence of equal scores on the four options showed that each person could distinguish between responses stating never (lowest level) to always (highest level) in teachers' activities joining PLN.

Data Analysis

The Rasch measurement model software, known as WINSTEPS version 3.73, was used to determine the validity and reliability of the instrument. Furthermore, the data were mathematically transformed by the

software into logit through the logarithmic function. The function converted raw ordinal (Likert-type) data into the same interval scale. Finally, the measurement model was calibrated by the conjoint measurement process (Bond & Fox, 2015; Engelhard Jr, 2013; Linacre, 2012; Sumintono, 2018; Sumintono & Widhiarso, 2015). The results of the program were 1) Summary Statistics to determine the overall quality of responses and items as well as the interactions occurring between the two, 2) Principal Component Analysis to analyze the data measured by the TPLNAQ (unidimensionality), 3) Rating Scale Analysis to verify the ranking of choices, and 4) Differential Item Functioning (DIF) to show that respondents from separate subgroups respond differently to several items.

FINDINGS

Teachers' Professional Learning Network (PLN) Activities Levels

Based on the Measured Person Summary Statistic Table (Appendix A), the overall mean score of +0.68 logit (SD = 1. 17) indicated that all teachers were at moderate levels in PLN activities level. A standard deviation of 1.17 indicated a very wide dispersion level, and teachers' PLN activities' level categorization is described based on demographic factors. The categorization used was empirical normalization based on the logit value of each respondent. Based on the Measured Person Summary Statistics Table (Appendix A), the data had a minimum and maximum of -2.14 and 4.08, respectively. The data categorized the scores into certain intervals using the Person Strata formula (Rasch.org, 2019; Wright & Masters, 2002). The results are classified into 4 categories, namely very high (2.53 - 4.08), high (0.97 - 2.52), moderate ((-0.59) - 0.96), and low ((-2.14) - (-0.58)), as seen in Table 2.

Table 2. Teachers' PLN Activities Level, Overall and According to Demographics

Demographics	Very High		High		Moderate		Low	
	f	%	f	%	f	%	f	%
Overall	33	7%	150	30%	258	51%	63	13%
Gender								
Female	18	6%	92	29%	165	52%	43	14%
Male	15	8%	58	31%	23	12%	90	48%
Age								
21 - 30 years	1	2%	20	31%	38	58%	6	9%
31 - 40 years	19	9%	68	32%	101	47%	27	13%
41 - 50 years	11	7%	47	28%	90	54%	19	11%
51 - 60 years	2	4%	15	26%	29	51%	11	19%
Experience								
1 - 10 years	3	2%	50	32%	88	56%	17	11%
11 - 20 years	23	9%	64	26%	128	52%	30	12%
21 - 30 years	6	7%	32	38%	33	39%	13	15%
31 - 40 years	1	6%	4	24%	9	53%	3	18%
Qualification								
Postgraduate	7	6%	49	42%	51	43%	11	9%
Undergraduate	26	7%	101	26%	207	54%	52	13%
Certification								
Passed	23	7%	105	31%	169	49%	46	13%
Not yet in	8	6%	36	28%	67	53%	16	13%
In Process	2	6%	9	26%	22	65%	1	3%

Differences in Teachers' Professional Learning Network (PLN) Activities Based on Demographic Factors

Inferential statistics of testing differences in teachers' PLN activities using analysis of variance (ANOVA) showed that only the qualifications factor had a significant difference at $p < 0.05$ (Table 3). Other demographic factors such as gender, age, teaching experience, and certification did not show any significant difference statistically.

Table 3. ANOVA of Teachers' Demographic Factors

Demographics	F-test
1. Gender	0.280
2. Age	1.818
3. Experience	0.267
4. Qualification	5.844*
5. Certification	0.125

Note: *p < 0.05

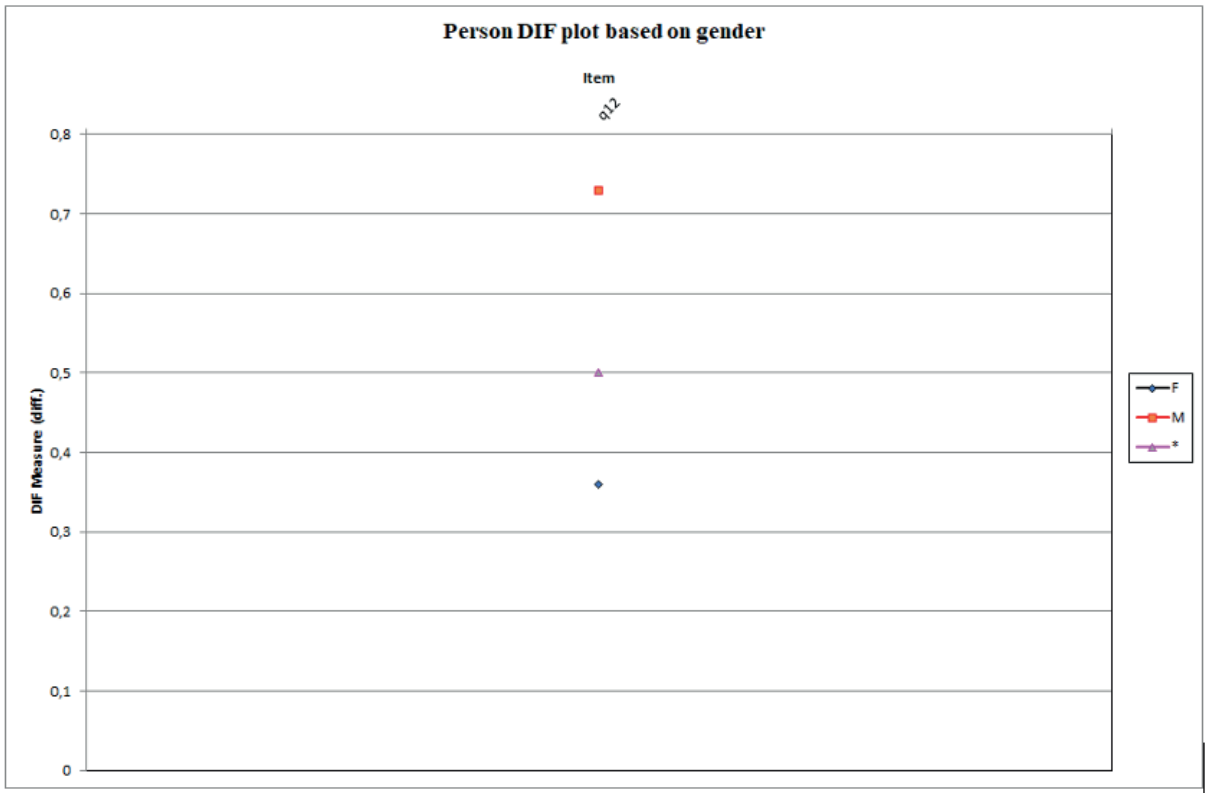
Differential Item Functioning (DIF) of Respondents' Demographic Factors in Teachers' Professional Learning Network (PLN) Activities

The next step is to analyze the differences between the respondents' demographic factors. The level of activity in PLN is measured based on the concept of the five key elements of experiences from Krutka et al. (2016), namely engaging, discovering, experimenting, reflecting, and sharing. This was analyzed using Differential Item Functioning (DIF) analysis, which showed that respondents from separate subgroups responded differently to several items, thereby measuring different involvement at the item level (Boone et al., 2014). DIF analysis results showed that the demographic factors of gender, age, teaching experience, qualifications, and certification had significant response differences. Based on the DIF size standard (> 0.5 log) and the DIF t-value (> 2.0) (Bond & Fox, 2015; Boone et al., 2014), there were 14 out of 47 items with different demographic factors, as shown in Table 4 and Appendix D.

Table 4. Summary of Differential Item Functioning Based on Teachers' Demographic Factors

Demographic Factors	Item of Teachers' PLN Activities					Total
	Engaging	Discovering	Experimenting	Reflecting	Sharing	
Gender	q12	-	-	-	-	1
Age	q1, q12	-	-	-	-	2
Experience	q1, q6, q10, q12, q17	-	-	-	-	5
Qualification	q8, q12, q13, q16,	q23, q26,	q34, q35,	-	q42	9
Certification	q1, q5, q12	-	-	-	-	3

The differences among teachers, namely gender, age, teaching experience, qualifications, certification, and PLN activities level, are described. The analysis for each demographic factor mentioned is presented below.

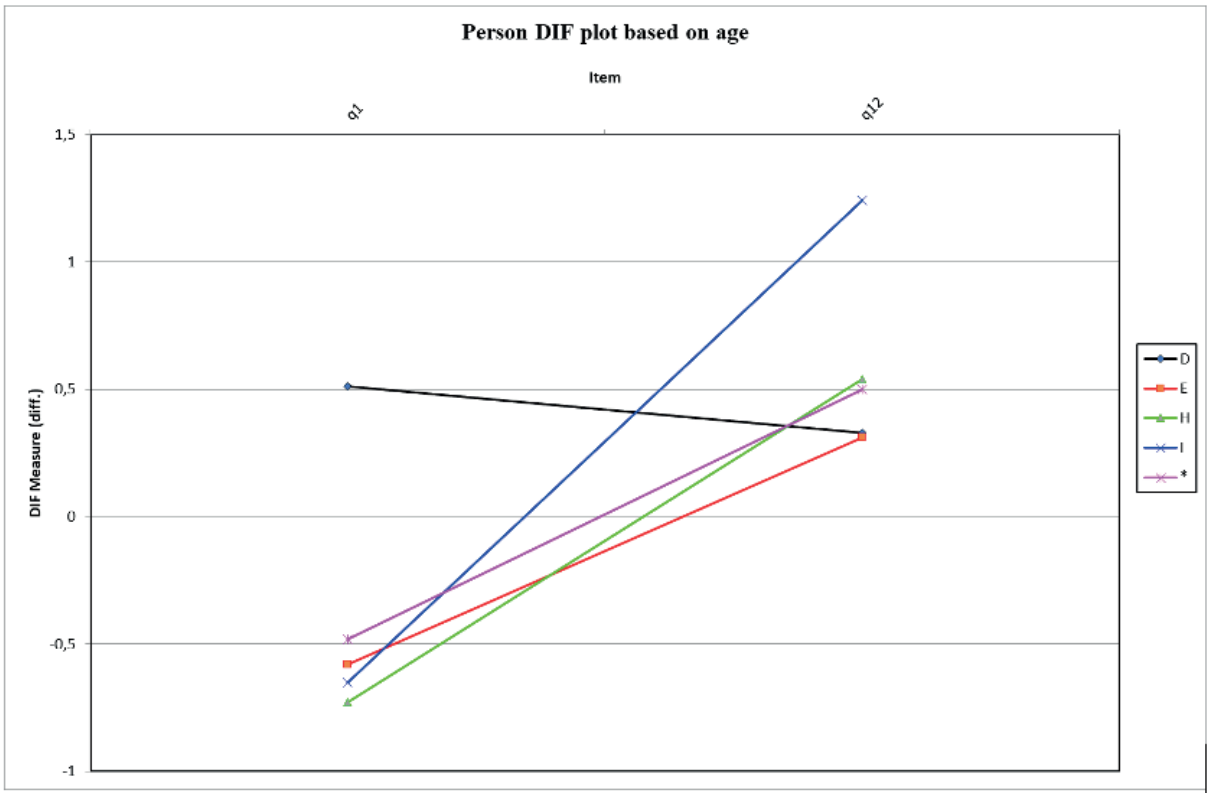


Note: F = Female M = Male * = Average

Figure 1. Person DIF Plot Based on Gender

Based on respondents' responses, one item on engagement elements was identified as having a significant difference based on gender (Table 4). Meanwhile, the other elements, such as discovering, experimenting, reflecting, and sharing, did not significantly differ. Figure 1 shows that the activities of female teachers were at a higher level than male in one of the engaging items, namely participating in professional learning activities in the form of training/technical guidance/workshops/online seminars on their initiative in the social media of teachers' community (Webinar/WhatsApp/Telegram) (q12).

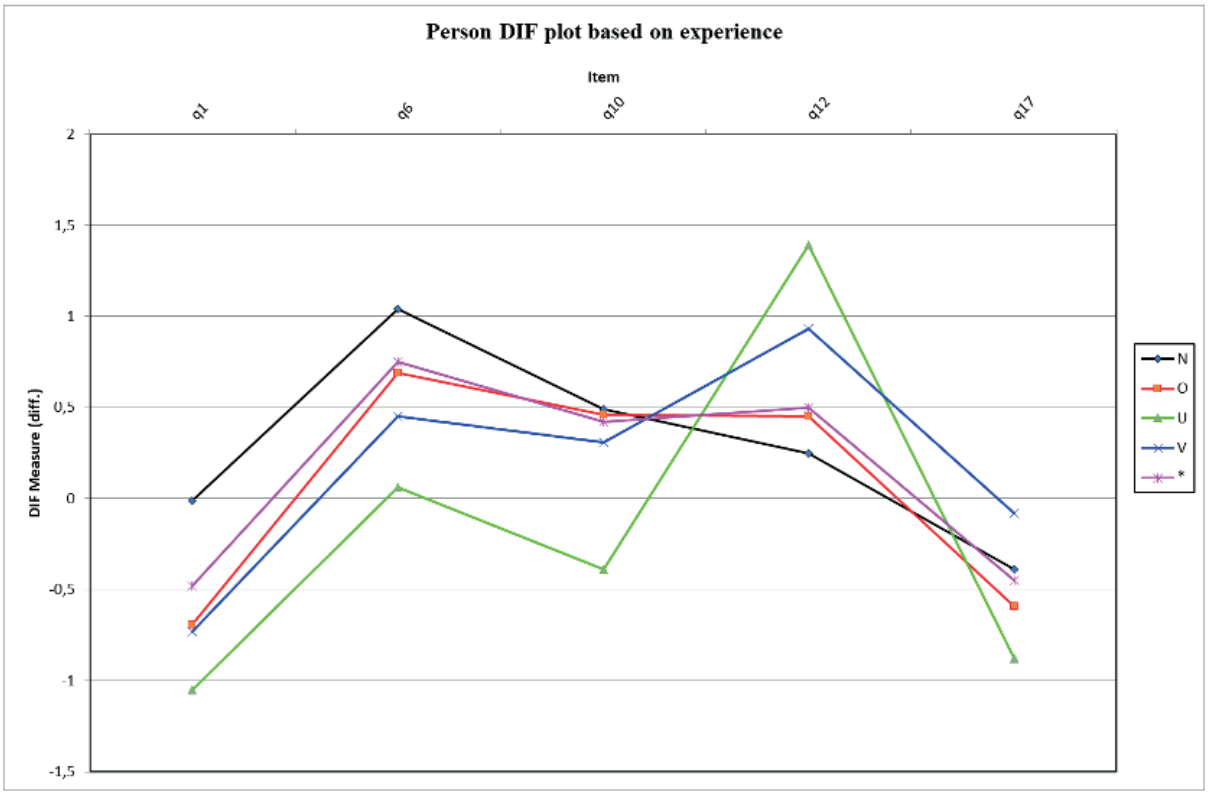
Judging by the age demographic factor, two items were identified as having a significant difference in the engaging element (Table 4). Meanwhile, the other elements (discovering, experimenting, reflecting, and sharing) did not significantly differ. Figure 2 shows that teachers aged 21-30 had a higher intensity of participating in learning activities at community forums (q1). In other PLN activities, older teachers (41-50 and 51-60 years) were more active in the training/technical guidance/workshop/online seminar on their initiative in the social media of teachers' community (Webinar/WhatsApp/Telegram) (q12), compared to younger teachers.



Note: D=21–30 years, E=31–40 years, H=41–50 years, I=51–60 years *=Average

Figure 2. Person DIF Plot Based on Age

Based on the demographic factor of teaching experience, five items were identified as having a significant difference in the engaging element while discovering, experimenting, reflecting, and sharing did not show a significant difference (Table 4). Figure 3 shows that teachers with less teaching experience tended to be more actively participating in learning activities (q1), discussing and sharing the results of observation, evaluation, and reflection with colleagues at school (q6), and joining the training/technical guidance/workshop/seminar in the school internally (q10). Teachers with excellent teaching experience tended to be more active in joining the training/technical guidance/workshop/online seminar in the social media of teachers' community (Webinar/WhatsApp/Telegram) (q12) and implementing knowledge/experience in teaching practices discussed in the social media of teachers' community (q17).



Note: N=1–10 years, O=11–20 years, U=21–30 years, V=31–40 years *=Average

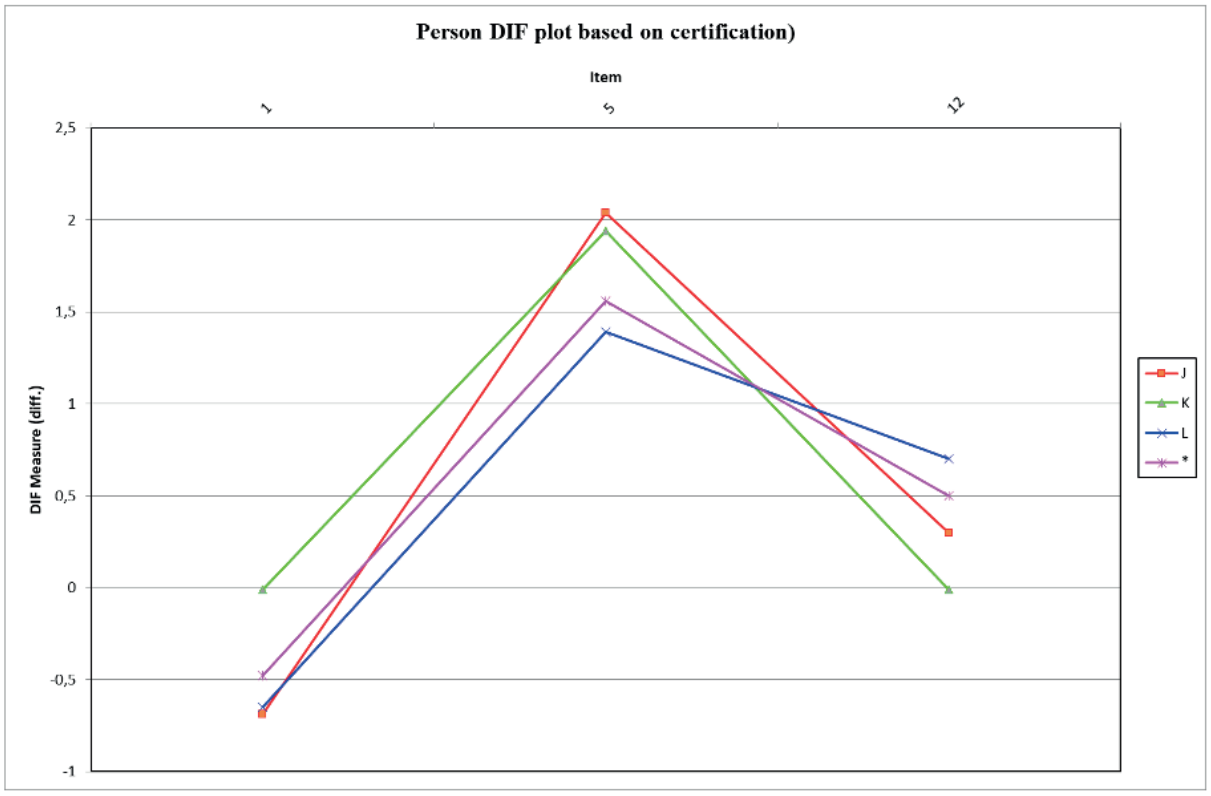
Figure 3. Person DIF Plot Based on Experience

Meanwhile, judging by teachers' qualifications and demographic factors, there were nine items identified as having significant differences in several elements, engaging (4 items), discovering (2 items), experimenting (2 items), and sharing (1 item). There are no items with significant differences in the reflecting element (Table 4). Figure 4 shows that undergraduate education teachers performed better in four activities on elements engaging, experimenting, and sharing. These include joining the learning innovation competition (q8), writing the results of implementation and reflection in the form of scientific papers (q34), publishing the results of implementation and reflection in the form of scientific journal articles (q35), and reflecting on the learning tools used (q42). Furthermore, postgraduate education qualification tended to be more active in five activities on elements engaging and discovering. These include terms of training/technical guidance/workshop/online seminar on their initiative in the social media of teachers' community (Webinar/WhatsApp/Telegram) (q12), actively participating in various learning activities (q13), reading and learning about knowledge/experience in teaching uploaded on the social media of teachers' community (q16), trying to obtain information that could change the new perspective in teaching following the current context when participating in learning activities through the teachers' community (q23), and trying to obtain innovative and applicable teaching strategies when participating in learning activities (q26).

Note: G = Bachelor P = Postgraduate * = Average

Figure 4. Person DIF Plot Based on Qualification

Based on the teaching certification's demographic factor, three items were identified with a significant difference in the engaging element, unlike others (Table 4). Figure 5 shows that teachers who have not participated in the certification program are more active in learning activities (q1), and those who were in the process tended to be more active in writing the results of observation, evaluation, reflection, or innovation development in the form of scientific papers (q5). Meanwhile, those who have passed the certification program tended to be more active in participating in training/technical guidance/workshops/online seminars on their initiative in the social media of teachers' community (Webinar/WhatsApp/Telegram) (q12).



Note: J = In Process K = Not yet L = Passed * = Average

Figure 5. Person DIF Plot Based on Certification

DISCUSSIONS

The findings indicated that all teachers were moderately in PLN activities. Therefore, teachers who join the social media-based PLN need to optimize their participation in professional learning activities. The data showed that only 37% of teachers were in high and very high categories, and 13% were still in the low level. Various research showed that social media is a potential tool to support professional learning. It can provide opportunities for teachers to connect, demonstrate a transformation of teachers' development strategies, and potentially increase professionalism in terms of applying their professional and pedagogical competencies (Patahuddin & Logan, 2019; E. Sari et al., 2012a; E. Sari & Lim, 2012a, 2012b; E. R. Sari, 2012; Sumaryanta et al., 2019). Furthermore, professional learning is a means to improve knowledge and skills in teaching practices. Teachers will gain a great deal, particularly during in-class practice, when the planning, processes, activities, and evaluations are well-managed. Therefore, there needs to be reflection and assessment of teachers' activities, forms of activities, and professional learning content. Previous research reported that several steps should be taken to maximize the benefits of learning to increase participants' engagement. These steps are that the activities designed should have a focus on content, emphasize an active learning approach related to policies and curricula, time sufficient and appropriate, develop collaborative participation, and determine the tasks and content of teachers' learning activities (Tanang & Abu, 2014; Zhang & Liu, 2019).

The variance analysis (ANOVA) indicated that only teachers' education qualifications differed significantly. At the same time, other demographic factors such as gender, age, teaching experience, and certification did not show statistically significant differences. However, some instrument items showed substantial differences in response to the teachers' sampled demographic factors, as described below.

Regarding gender demographic factors, the research data showed no significant difference in PLN's activity level between male and female teachers. However, female teachers are at a better level than male, namely on activities in participating in training/technical guidance/workshops/online seminars on their initiative on the social media of teachers' community (Webinar/WhatsApp/Telegram). This is in line with the findings of

previous research, which showed that in the use of technology, female teachers used various ICT resources and tended to be more active in using ICT in their classrooms. These have been taken to build networks and connect with the more incredible world to access information (Wiseman et al., 2018). Other research showed that male teachers significantly differed in the use and preferences of ICT tools and devices from female. However, they differed significantly in their use and preferences for online services (WhatsApp, text messaging, and search engine literature) from male teachers (Yaokumah et al., 2019). Online courses or training utilizing technology such as video and web conferencing and social media applications such as WhatsApp and Telegram have become a means to develop professional development more actively. In addition, social media-based PLN is implemented online, requiring flexible time in its implementation. Some females may face constraints such as lack of time due to other responsibilities. Variations in participation and time flexibility significantly affect online learning completion for females (Veletsianos et al., 2021). The masculinity dimension shows that Facebook and Synchronous Online Conferencing applications, such as Skype, can facilitate female teachers to participate more actively in academic discussions and interactions. Even though male members were more assertive than their peers, most female members had a firm voice in academic discussions (E. Sari & Lim, 2012a).

In the age demographic factors, there were no significant differences between the several groups regarding the Professional Learning Network activities level. However, some factors were identified as having significant differences. Research data showed that teachers aged 21-30 are more active in learning activities in community forums. Meanwhile, teachers of older age (41-50 and 51-60 years) were more involved in the training/technical guidance/workshop/online seminar activities on their initiative on social media (Webinar/WhatsApp/Telegram). This appears to be relevant to research findings on the teaching experience factor. This factor did not significantly differ among several teaching experience groups regarding PLN activities level. However, there were several activities identified that showed differences. For example, those with less teaching experience tended to be more active in several activities, such as participating in learning activities, discussing and sharing the results of observation, evaluation, and reflection with colleagues at school, and joining the training/technical guidance/workshop/seminar in the internal school. Meanwhile, those whose teaching experience was greater tended to be more active in other activities, namely joining the training/technical guidance/workshop/online seminar on their initiative (Webinar/WhatsApp/Telegram) and implementing knowledge/experience in teaching practice discussed in the social media of teachers' community.

The findings on the age factor and teaching experience were in line with the concept of the professional life phase of teachers (Day, 2008, 2013; Day & Gu, 2007; Sammons et al., 2007). In the initial phase, the young teachers whose teaching experience is less focused on learning to build their identity and competence in the classroom and developing evidence and responsibility in their work to motivate, foster commitment, and behave effectively. In this phase, the influence of the principal, colleagues, and culture in the school becomes an essential factor in becoming a professional teacher. Therefore, school leaders need technology leadership to promote young teachers to start active in professional learning or development. In this case, the suitable activities of young teachers will positively impact the school. This can be exemplified by a research that significantly influenced professional development as a moderating factor between technology leadership and school integration (Thannimalai & Raman, 2018). Young teachers with less teaching experience actively represent that phase in the learning process and their communities through professional development, building a sense of professional identity, and creating effective classes and learning. This is also consistent with other research, where young and middle-aged learning about oneself tends to be shown (Louws et al., 2017). The findings indicated that young teachers have considered the importance of teachers' community forums, discussions with colleagues, and learning activities in internal schools to become appropriate professional tools.

In the final phase of professional life, old teachers with experience have shifted to maintain their commitment and effectiveness until they slowly show lower performance. This phase requires strong support from various sides, from the internal and external school as well as the family of teachers (Day, 2008, 2013; Day & Gu, 2007; Sammons et al., 2007). The results indicated that teachers at this phase tend to take the initiative to be more active in informal activities to obtain external support, such as being involved in teachers' community, professional organizations, and social media. Other research showed that mid-career teachers and those in the final years of their careers tend to be active and learn about technological innovations for classroom

learning (Louws et al., 2017). These can be obtained from informal activities through learning from other teachers about the activities of the community and social media. The findings indicated that older teachers with more excellent experience tend to be more active in online learning activities (Webinar/WhatsApp/Telegram). They also showed the same indications on implementing knowledge/experience in teaching, which were discussed on the social media of teachers' community.

There are several differences based on age and teaching experience, which are also reinforced by the concept of the phases of professional teachers' life. It is necessary to pay attention to the meaning of the concept when discussing professional development. In determining the level of significance, self-actualization and self-transcendence play an essential role. The meaning of life is directly proportional to the development of talents and potential as well as the fulfillment of a person's quality and capacity (Suyatno et al., 2020).

Judging by the demographic factors of teachers' qualifications, the research findings showed a significant difference in PLN activities level between undergraduate and postgraduate education qualifications. Teachers with postgraduate qualifications tended to perform better at PLN activities level. However, some activities were identified as having differences. They tended to be more active in training/technical guidance/workshop/online seminars on social media (Webinar/WhatsApp/Telegram) and actively participating in various activities. The same indication was also shown in the following activities, reading and learning about knowledge/experience in teaching practice uploaded on social media, analyzing information that changes the new perspective in teaching, and looking for innovative and applicable strategies. Therefore, better educational qualifications of teachers will promote knowledge, understanding, perceptions, and activities in terms of PLN activities. This finding aligns with previous research, where academic qualifications significantly affect professional behaviour and learning activities (Tanang & Abu, 2014). Furthermore, there is a significant relationship between teachers' qualifications and perceptions of community-based professional learning practices. The qualifications at the school level can increase with their perceptions about learning practices, provide solid professional learning, and contribute to their understanding of the forms of teachers' development (Ho et al., 2016; Williams, 2011).

Based on the demographic factors of certification, the research findings did not show any significant difference in PLN activities level among teachers who have passed the certification program with those in the process of participating. The findings also showed that there was not much difference in the level of activity in various professional learning activities. Teachers who have not participated in the certification program tended to be more active in learning activities in the community forums. Teachers in the process of experiencing were more involved in writing observations, evaluations, reflections, or innovation development in the form of scientific papers.

Teachers who passed the certification program tended to be more active in training/technical guidance/workshops/online seminars on their initiative on the community's social media (Webinar/WhatsApp/Telegram). In the context of professional development, the certification program is a government obligation stipulated in the law as a form of quality assurance. It determines teachers' eligibility in carrying out their duties as professional educators, improves the process and learning outcomes, improves teachers' welfare, and increases their dignity to realize quality national education (Maisah et al., 2019; Marzuki, 2009). The certification program has not been optimized to promote teachers to develop competence and professionalism. This is in line with teachers reform conducted by the World Bank and other research that showed no substantial evidence of the effectiveness of certification (Chang et al., 2014; Kusumawardhani, 2017). Research findings on the demographic factors showed a significant challenge for teachers who have passed certification. Since teachers have been declared to meet the standards, they should continue to maintain and develop the competence and professionalism by maximizing activities in professional learning. The main objective of the Indonesian government's incentives is to optimize the use of these incentives to develop competence and professionalism.

Several specific PLN activities items had significant differences in all teachers' demographic factors, specifically in the engaging element, as shown in Table 4. Therefore, they should be essential in designing, implementing, and evaluating professional learning programs, including PLN with social media platforms. This is in line with the recommendations of several previous research that paid attention to teachers' demographics in professional development programs, specifically to attract participation in various learning activities (Copur-

Gencturk & Thacker, 2021; Downer et al., 2009; Loucks-Horsley et al., 2010; Powell & Bodur, 2019; Saka, 2013). The learning community should facilitate differentiated learning activities to accommodate teachers' diverse characteristics (demographics). Practically, they have to prepare topics, activities, models, and learning modes that vary according to the needs. This will increase their participation in various PLN activities in terms of engaging, discovering, experimenting, reflecting, and sharing. Based on this research data, teachers with postgraduate educational backgrounds need to facilitate learning innovation activities, writing the results and reflection, publishing scientific journal articles or best-practice books, and reflecting on the learning tools used.

Another example is the young teachers whose experience is less, which needs to be facilitated in activities to build their identity and competence to motivate, foster commitment, and behave effectively. Meanwhile, old teachers with experience tend to take the initiative to be more active in informal activities as a means of receiving external support in teachers' community, professional organizations, and social media (Day, 2008, 2013; Day & Gu, 2007; Sammons et al., 2007). Teachers who have not passed certification are more active in learning activities through internal forums in teachers' community that facilitate PLN. Therefore, they need to be promoted and prioritized to join the certification program. Teachers in the certification program process are more active in writing the results of observation, evaluation, reflection, or innovation development in the form of scientific papers. They should be allowed to demonstrate their competence in teaching through writing scientific journal articles, community newspapers, or best-practice books. Teachers who have passed the certification have more initiative to participate in self-development programs through training/technical guidance/workshops/online seminars. They need to be facilitated by organizing these events in the teacher-learning communities. The information related to the event is through the community's social media. Practically, accommodating the diversity of needs due to the various demographic factors will promote an increase in teachers' activity and participation in social media-based PLN.

This is also a challenge for policymakers working on developing professional learning for teachers in Indonesia. The development of teachers' communities oriented toward professional learning should also be facilitated. Existing communities should be directed towards effective professional learning for real benefits. In terms of effective professional learning, Jana Hunzicker explained that the involvement of teachers in learning activities focused on teaching, collaboration, and sustainability is the key to effective development (Hunzicker, 2011). With these characteristics, they are more likely to consider relevant and authentic professional learning to improve teaching practices. Sitti Maesuri Furthermore, Patahuddin also stated the same idea that effective professional learning fulfills at least five characteristics, namely 1) focuses on an event that is conducted and ongoing, 2) collaborative and aims to develop a learning community among teachers, 3) student-oriented, focuses on student-centered approaches to teaching, 4) considers individual teachers and their context, and 5) the main focus is to increase knowledge for teaching (Patahuddin & Logan, 2019). The realization of effective professional learning will motivate teachers to participate more actively in various activities, and active participation significantly positively impacts beliefs and practices as well as student performance (Tanang & Abu, 2014).

CONCLUSION

Indonesia needs to utilize technology to develop competencies and professionalism, with a more than four million teachers' population. PLN using social media platforms are one form of implementation of technology by teachers' communities in the context of informal professional learning. This research has investigated three communities in Indonesia, and the findings indicated that all teachers had a moderate level of PLN activities. Generally, teachers who participated in social media-based PLN still need to improve their activities when participating in professional learning such as engaging, discovering, experimenting, reflecting, and sharing. Even though only qualification factors showed significant differences in almost all elements, several specific PLN activities items had substantial differences, specifically in the engaging element. Theoretically, this research provides insight that teachers' demographic factors should be essential in designing, implementing, and evaluating professional learning programs, including PLN with social media platforms. Attention will build positive perceptions of learning experiences, promote active participation, inform program improvement and delivery strategies, and uncover specific teaching resources. This research

recommends that conformity with teachers' demographic factors can increase PLN experiences in terms of engaging, discovering, experimenting, reflecting, and sharing. The learning community should prepare topics, activities, and modes of teachers' learning. Accommodating the diversity of needs due to the various demographic factors will promote teachers' activity and participation in social media-based PLN.

Research Limitations and Future Research Needs

Concerning the limitation of this research, the sample is small compared to the population in Indonesia, which is more than four million teachers. Furthermore, the three teachers' communities investigated were few compared to that of Indonesia. Current phenomenon is the rapidly growing number of teachers' communities whose base of professional learning activities utilize social media platforms. This research is also limited to a quantitative perspective, hence, it has not been investigated deeply through qualitative perspectives, such as motives, obstacles, challenges, and benefits teachers feel when participating actively in social media-based PLN.

The recommendation is for further findings to be interested in analyzing social media-based PLN in terms of teachers' demographics, such as factors with a dominant influence on teachers' activities. In addition, it examines how the demographic characteristics of teachers affect learning outcomes in PLN. The preferences of teachers in using social media and their influence on the activity level are seen from demographic factors. These should be studied to provide meaningful input for evaluating and redesigning an effective social media-based PLN. It is also suggested to complement the following research with a qualitative perspective to obtain more comprehensive data and explore the impact of change on students.

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APPENDIX A

Summary Statistic

```
INPUT: 504 Person  47 Item  REPORTED: 504 Person  47 Item  4 CATS  WINSTEPS 3.73
-------------------------------------------------------------------------------

     SUMMARY OF 504 MEASURED Person
-------------------------------------------------------------------------------
|           TOTAL                          MODEL         INFIT        OUTFIT    |
|           SCORE     COUNT     MEASURE    ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      132.7      47.0         .68      .24      1.01    -.3   1.00    -.3 |
| S.D.       20.3        .0        1.17      .03       .51    2.5    .50    2.4 |
| MAX.      179.0      47.0        4.08      .39      2.41    5.1   2.42    4.6 |
| MIN.       76.0      47.0       -2.14      .21       .18   -6.0    .17   -6.1 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .27 TRUE SD    1.14  SEPARATION  4.24  Person RELIABILITY  .95 |
|MODEL RMSE    .24 TRUE SD    1.15  SEPARATION  4.75  Person RELIABILITY  .96 |
| S.E. OF Person MEAN = .05                                                   |
-------------------------------------------------------------------------------
Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .96

     SUMMARY OF 47 MEASURED Item
-------------------------------------------------------------------------------
|           TOTAL                          MODEL         INFIT        OUTFIT    |
|           SCORE     COUNT     MEASURE    ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     1423.3     504.0         .00      .07       .98    -.8   1.00    -.5 |
| S.D.      174.8        .0         .86      .00       .33    4.5    .32    4.3 |
| MAX.     1638.0     504.0        3.02      .08      2.27    9.9   2.23    9.9 |
| MIN.      792.0     504.0       -1.15      .07       .55   -8.2    .56   -8.2 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .08 TRUE SD     .86  SEPARATION 11.18  Item   RELIABILITY  .99 |
|MODEL RMSE    .07 TRUE SD     .86  SEPARATION 11.81  Item   RELIABILITY  .99 |
| S.E. OF Item MEAN = .13                                                     |
-------------------------------------------------------------------------------
UMEAN=.0000 USCALE=1.0000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
23688 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 42769.06 with 23136 d.f. p=.0000
Global Root-Mean-Square Residual (excluding extreme scores): .6153
```

APPENDIX B

Standardized Residual Variance

```
INPUT: 504 Person  47 Item  REPORTED: 504 Person  47 Item  4 CATS  WINSTEPS 3.73
-------------------------------------------------------------------------------

     Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                          -- Empirical --     Modeled
Total raw variance in observations     =      85.9 100.0%        100.0%
  Raw variance explained by measures   =      38.9  45.3%         44.8%
    Raw variance explained by persons  =      16.9  19.7%         19.5%
    Raw Variance explained by items    =      22.0  25.6%         25.3%
  Raw unexplained variance (total)     =      47.0  54.7% 100.0%   55.2%
    Unexplned variance in 1st contrast =       7.6   8.8%  16.2%
    Unexplned variance in 2nd contrast =       4.7   5.5%  10.0%
    Unexplned variance in 3rd contrast =       4.2   4.9%   9.0%
    Unexplned variance in 4th contrast =       3.2   3.7%   6.8%
    Unexplned variance in 5th contrast =       2.1   2.4%   4.4%
```

APPENDIX C

Rating Scale Analysis

```
INPUT: 504 Person  47 Item  REPORTED: 504 Person  47 Item  4 CATS  WINSTEPS 3.73
-------------------------------------------------------------------------------


SUMMARY OF CATEGORY STRUCTURE.  Model="R"
-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------|
|  1   1    1800   8| -1.34 -1.39|  1.05  1.06||  NONE   |( -3.11)| 1
|  2   2    5250  22|  -.32  -.23|   .91   .94||   -1.85 |  -1.22 | 2
|  3   3   11955  50|   .89   .83|   .89   .94||    -.53 |    .98 | 3
|  4   4    4683  20|  2.05  2.11|  1.09  1.06||    2.38 |(  3.52)| 4
-------------------------------------------------------------------
OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.

-------------------------------------------------------------------------------------
|CATEGORY    STRUCTURE    |  SCORE-TO-MEASURE    | 50% CUM.| COHERENCE       |ESTIM|
| LABEL    MEASURE  S.E. | AT CAT. ----ZONE----|PROBABLTY| M->C C->M  RMSR |DISCR|
|-----------------------+---------------------+---------+-----------------+-----|
|   1      NONE         |( -3.11) -INF   -2.28|         |  70%  22% 1.1038|     | 1
|   2       -1.85   .03 |  -1.22  -2.28   -.25|   -2.05 |  50%  51%  .6266|  .96| 2
|   3        -.53   .02 |    .98   -.25  2.51|    -.38 |  64%  82%  .3870| 1.10| 3
|   4        2.38   .02 |(  3.52)  2.51  +INF |    2.43 |  69%  35%  .7901|  .94| 4
-------------------------------------------------------------------------------------
M->C = Does Measure imply Category?
C->M = Does Category imply Measure?

        CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      -+------+------+------+------+------+------+------+------+-
R  1.0 +                                                          +
O      |                                                          |
B      |11                                                        |
A      |  11                                                    4|
B   .8 +    11                                                44 +
I      |      11                                            44    |
L      |        11                                       44       |
I      |          1                  333333333        4           |
T   .6 +           1                33         33      4          +
Y      |            11            33             33  44          |
    .5 +              1   2222    3                3*            +
O      |               *22    2223                  4 3           |
F   .4 +             22 1      3322               44   33         +
       |            22    1    3    22           4       3        |
R      |          22       11 3      2         44         33      |
E      |        22           3*        22      4             33    |
S   .2 +     22              3  1          22  44                33 +
P      |  222              33    11         4**2                   3|
O      |22             333         111   444    222                |
N      |         33333               44***11        22222          |
S   .0 +********4444444444444444       1111111111111************+
E      -+------+------+------+------+------+------+------+------+-
       -4     -3     -2     -1      0      1      2      3      4
```

APPENDIX D

Summary of Differential Item Functioning Based on Teachers' Demographic Factors

Item	Statement	Demographic Factors				
		Gender	Age	Experience	Qualification	Certification
q1	participating in teachers' learning activities at teacher community forums		√	√		√
q5	writing the results of observation, evaluation, reflection or innovation development in the form of scientific papers					√
q6	discussing and sharing the results of observation, evaluation, and reflection with colleagues at school			√		
q8	joining the learning innovation competition				√	
q10	joining the training/technical guidance/ workshop/seminar in the school internally			√		
q12	participating in training/technical guidance/ workshops/online seminars on own initiative in the social media of teachers' community (Webinar/WhatsApp/ Telegram)	√	√	√	√	√
q13	actively participating in various learning activities on the social media of teachers' community				√	
q16	reading and learning about knowledge/ experience in teaching uploaded on the social media of teachers' community				√	
q17	implementing knowledge/experience in teaching practices discussed on the social media of teachers' community			√		
q23	trying to obtain information that could change the new perspective in teaching that is following the current context when participating in learning activities through teachers' community				√	
q26	trying to obtain innovative and applicable teaching strategies when participating in learning activities through teachers' community				√	
q34	writing the results of implementation and reflection in the form of scientific papers				√	
q35	publishing the results of implementation and reflection in the form of scientific journal articles or best practice books				√	
q42	reflecting on the learning tools used so far				√	