Dual-mode teacher professional development: challenges and re-visioning future TPD in Indonesia

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Dual-mode teacher professional development: challenges and re-visioning future TPD in Indonesia

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This paper presents the results of a two-year research project aimed at developing a teacher professional development (TPD) model in Indonesia. New government policies in this nation, its archipelagic nature, vast numbers of teachers and scarcity of support resources present a unique challenge to TPD. A needs assessment was conducted to identify teachers' professional needs. Based on the results of this assessment, a dual-mode TPD that combines face-to-face sessions and online sessions was developed. Participation in face-to-face sessions was relatively high but the participation rate in online sessions was very low. Incentives, teachers' autonomy as professional learners, ICT skills and infrastructure are important considerations when designing TPD in Indonesia. This study and an analysis of TPD policy allow us to suggest future directions for TPD in Indonesia.

Keywords: dual-mode professional development; online training; teacher certification; teacher education; teacher education futures; teacher professional development in Indonesia

Introduction

The context of teacher professional development in Indonesia

Indonesian government policies and initiatives are creating an environment of change in teacher professional development (TPD). The enactment of the 2005 Law on Teachers and Lecturers (Republik Indonesia 2005) has brought significant changes to teacher education, teacher promotion policy, salary schemes and TPD. This article reports on a recent study of a TPD project and suggests directions TPD might take in the future.

TPD is mainly provided by three different providers, namely the government, communities, and teacher associations. The government is represented by two ministries (Ministry of Education/MOE and Ministry of Religious Affairs/MORA). MOE offers TPD programs through the Directorate General of Basic Education, Directorate General of Secondary Education, and Directorate General of Higher Education, while MORA provides TPD through the Directorate General of Islamic Education. In addition, MOE runs subject-based teacher training centres that provide TPD for secondary school teachers. TPD offered by the government is formal, fully covered financially and invitation based.

Communities are the second major TPD providers. These include companies, NGOs and teacher associations. TPD organised by these providers is less formal,

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partly self-financed, and self-initiated or invitation based. The third major TPD providers are teacher forums. Teacher forums usually consist of teachers who work at the same district or sub-district. Teachers of the same school subject are given one day off each week for a TPD session. If a teacher forum for biology teachers were on Wednesdays, for example, schools would not be allowed to schedule biology on Wednesdays because the teachers would be expected to attend that forum. Some schools also provide travel allowances for teachers to attend forums.

The huge numbers of teachers, the geography of Indonesia and limited funding create difficulties in conducting sustainable TPD for all teachers. Providing TPD for more than 2.6 million teachers (Departemen Pendidikan Nasional 2009) is an immense amount of work for providers. A number of large-scale projects were supported financially by UNESCO, the United Nations Development Programme and the World Bank, and although these projects were successful in improving teachers' competencies, the success was not sustained. Rather, it was hindered by lack of both financial support and teacher commitment (Adey et al. 2004).

The archipelagic geography of Indonesia presents a considerable challenge to conducting nationwide TPD. With teachers spread over more than 10,000 islands, many of them very isolated, travelling to a training centre may require a couple of days. It is not possible, therefore, to use conventional strategies to conduct TPD that covers all teachers.

The most common strategy chosen by the government has been the Training of Trainers (ToT) model. Teachers who have successfully participated in this training are supposed to train other teachers. However, Flint, Zisook, and Fisher (2011) said this ToT model of TPD is not effective in contributing to teachers' learning. Widodo et al. (2006) conducted a study with science teachers at three districts in West Java Province and found a similar result. This study found that only around 50% of teachers applied what they had learnt in TPD, with only 27% of them applying it for more than one year. Since 2006 there has been an initiative to adopt a Japanese TPD model called Lesson Study (Saito et al. 2006), which is considered effective for improving teaching processes and student achievements (Firman 2010). Even so, Firman (2010) warned against a backwash phenomena. Without sufficient support from the school and the supervisors, innovations will not be sustained. Moreover, adaptations are needed before applying it to the Indonesian context. For example, two models of Lesson Study (school based and subject matter based), adopted from Japan and introduced in Bandung and Sumedang (two districts in West Java Province), have been found difficult to apply in Kalimantan, where schools are isolated and transportation is an issue (Widodo et al. 2010).

A survey on the impact of participation in TPD on teaching practice has identified four weaknesses in the existing forms of TPD (Widodo et al. 2006). First, although there are a number of programs, they involve a limited number of teachers, many of whom participate in several programs. Second, TPD is usually top down, with predetermined subjects, strategies, instructors and timetables. As a result, many problems faced in teaching practice remain unsolved. Third, conducting TPD programs at training centres means teachers have to leave their schools and classes are left without teachers. Finally, schools do not provide sufficient support for the teachers to apply the innovations they learn during TPD. As Watson and Manning (2008) suggested, in-school support is required for teachers to implement what they learn from TPD.

The design of future TPD programs should reduce these weaknesses and allow as many teachers as possible to participate without removing them from their

classrooms. An alternative TPD should also facilitate teachers to share their problems and experiences as well as helping them to get expert professional support when necessary.

Dual-mode TPD

A possible solution to these current problems is to use information and computing technology (ICT) for TPD. In recent years teachers have been encouraged to use ICT when their schools are supported by ICT facilities. Although the utilisation of e-learning in schools is not as intensive as in higher education (Ballis and Fetscher 2009; Riandi et al. 2009), a number of initiatives employ e-learning in schools (Anggraeni 2010; Nugraha 2009; Suhendi 2009). These studies reported that ICT-based learning improves students' understanding (Anggraeni 2010; Nugraha 2009) and facilitates their creative thinking skills (Nugraha 2009), motivation (Mistler-Jackson and Songer 2000; Suhendi 2009) and learning outcomes (Higgins and Moseley 2001).

The potential for the use of ICT in TPD is strong. In 2008 internet usage in Indonesia was 10.5% of the total population, with the number of users growing to 1150% (Latchem and Jung 2010). The use of ICT for TPD is not as common as its use for pre-service teacher training (Sorensen et al. 2007). Noh et al. (2004) found that some teachers prefer online training because it enables them to overcome issues of time and space. However, they also found that some teachers prefer face-to-face training because it allows them to have direct interaction and experience. Indonesian universities acknowledge that teachers of the future should be competent in ICT because its use will be very common in schools, and ICT-based TPD is likely to become a familiar model of TPD (Universitas Pendidikan Indonesia 2010).

Although ICT will become more influential in TPD, it will never be the only solution to current problems. Face-to-face training will continue to play an important part (Noh et al. 2004). A dual-mode delivery system in which conventional face-to-face training and online training complement each other should increase the impact of TPD (in this paper, the notion of 'dual-mode' is intentionally used instead of 'blended learning' because online and face-to-face are both modes of delivery).

Research on dual-mode delivery for TPD is still limited. Studies show that dual-mode TPD is a viable model for TPD (Matzat 2013; Owston et al. 2008), but they also suggest more research is needed to examine the impact of blended TPD on students' learning. Positive results on the application of 'dual-mode' delivery have been reported. It creates a positive learning climate and enhances students' performance expectations (Wu, Tennyson, and Hsia 2010), understanding (Kavadella et al. 2011; Olympiou and Zacharia 2012) and mathematical thinking (Kashefi et al. 2012).

The aim of this project was to develop a dual-mode TPD program in which part of the training is conducted in conventional ways and the rest is delivered through e-learning programs. Dual-mode TPD programs have been shown to have four advantages over conventional TPD. First, in dual-mode TPD teachers do not need to leave their classes when courses are conducted online. Second, teachers have the flexibility to choose attendance times that suit their schedules. Third, since the internet is accessible almost everywhere in Indonesia, geography should not be a hindrance to dual-mode TPD. Finally, dual-mode TPD allows teachers to share their individual teaching problems with other teachers and consult experts via the internet.

The use of the internet may open teachers' minds to the importance of improving their professional skills and thereby encourage them to participate in TPD programs (Yumuk 2002).

New model for preparing teachers

The enactment of new teaching legislation in Indonesia has also changed the teacher preparation system (Figure 1). In the previous system, teacher education was conducted solely by universities. During a four-year program pre-service teachers learnt subject matter and pedagogy simultaneously and by the end of their study they would do a semester of teaching practice. In the new system, there are two pathways to becoming a teacher. The first pathway is quite similar to the old system
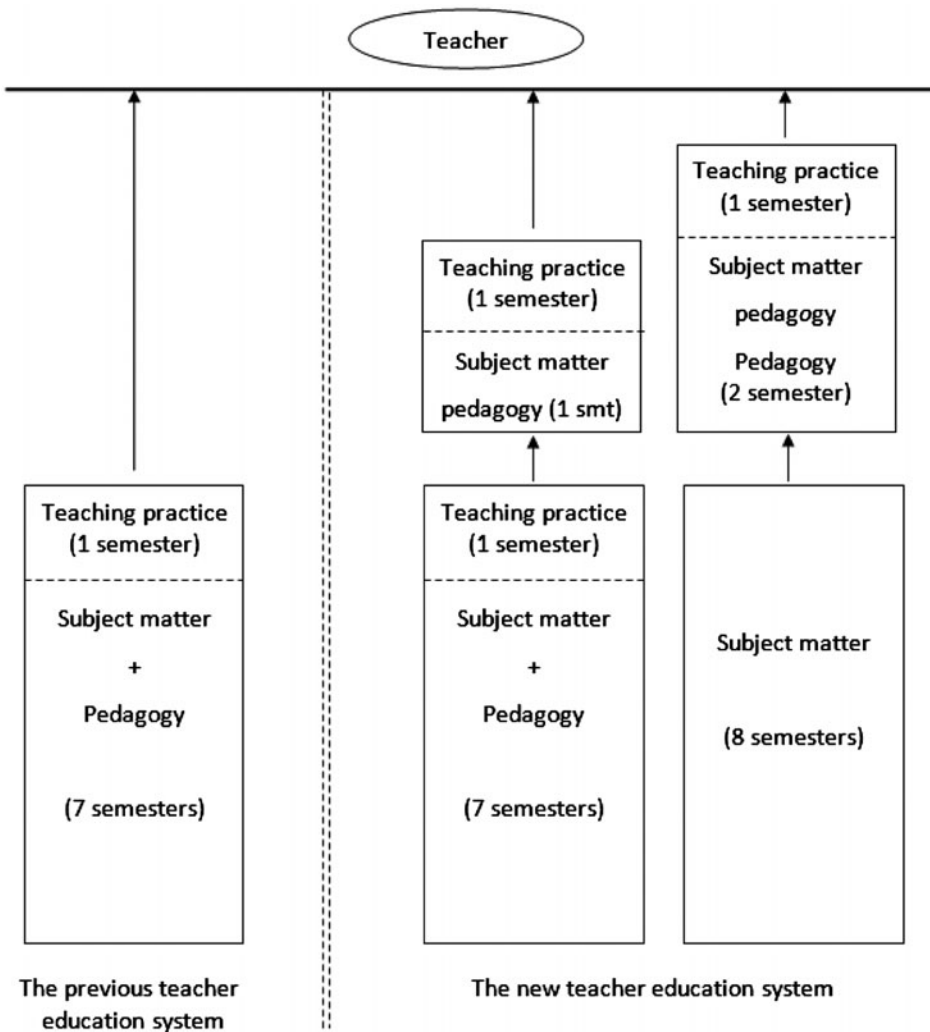

Figure 1.   The previous and the new teacher education system.

but there is an additional program called 'Professional Training Program'. This program consists of a series of workshops on subject matter pedagogy, classroom action research and one semester of teaching practice.

The second pathway allows graduates of non-education majors to become teachers by taking professional teaching practice. There is a slightly different curriculum for non-education majors. They must take pedagogy courses, participate in workshops on subject matter pedagogy and finally undertake teaching practice (Universitas Pendidikan Indonesia 2010).

Methodology

This paper is based on a two-year research project that consisted of three main steps. The first step was identifying teachers' professional development needs. It was conducted by distributing needs assessment questionnaires to teachers during teacher forum sessions. Teachers were informed that their participation was voluntary and no financial support from the research team would be provided. The second step consisted of face-to-face training sessions conducted twice for every teacher forum. Each session lasted about four hours. The face-to-face sessions focused on improving teachers' understanding of subject matter, pedagogy and ICT. The third step, online training, was conducted by providing online professional development services on a website. Each teacher was provided with a unique password so that it was possible to identify those who participated in the online program and the material they accessed.

Participants of the study were science teachers from Bandung and Sumedang. Bandung represents an inner-city area while Sumedang represents a small town whose schools are located in isolated and remote areas. Both districts were purposely selected because they have been receiving intensive support from the Indonesian government and the Indonesia University of Education through a large-scale Lesson Study project. The project was due to finish in 2009. Our study aimed at developing a low-cost TPD model as a continuation of the project.

At the beginning of the study there were 102 teachers participating (Table 1). The average number of years of teaching experience was 14.4 years, but with significant variation (1 year to 37 years).

Data were collected through a questionnaire, field notes, internet access records and interviews. To ensure genuine responses from the teachers, interviews were conducted in small groups, though they were individually assessed. In Indonesian culture, a female teacher may find herself uncomfortable being interviewed individually by a man. To make such interview sessions more comfortable, there were two female teachers in each session or else a female colleague accompanied the male interviewer.

Table 1.   Participants of the study.

District	Total participants	Gender		Teaching experience	
		Female	Male	≤ 14.4 years	≥ 14.4 years
Bandung	36	27	9	14	22
Sumedang	66	40	26	39	27
Total	102	67	35	53	49

Results

The first part of this section presents the results of the needs assessment conducted in the first year. These results are based on the questionnaire distributed to the members of the teacher forums in the two districts. This was a tick-box questionnaire that allowed the choice of one or more options. Blank spaces were also provided for the respondents to write additional information.

Teachers' professional needs

Table 2 shows that teachers need training on almost every pedagogical aspect listed. Teachers showed high interest in teaching models/strategies, teaching media, laboratory work and e-learning. This suggests teachers are very focused on how to organise lessons in their classrooms, a result similar in part to Kennedy and Clinton's findings (2009) that curriculum and teaching strategies are highly rated by teachers as important TPD topics. Respondents in our study, however, did not pick up curriculum as an important TPD topic.

Table 2 shows that many teachers perceive that education quality could be improved with new teaching models/strategies. They blame current teaching strategies for poor education quality. Although teaching strategy is not the only factor that contributes to education quality, many research studies and government projects have focused on this issue (see Widodo 2008).

Mode of TPD

The effectiveness of TPD programs can be improved by taking into account teachers' needs and expectations (Louck-Horsley et al. 2010; Watson and Manning 2008). This study has tried to identify teachers' needs and expectations of the TPD model. The statistics presented in Table 3 indicate that teachers expect a new TPD model and align with previous studies showing teachers expect both face-to-face TPD and web-based training programs (Noh et al. 2004). A dual-mode TPD that combines both face-to-face and online sessions should fit such expectations.

Table 2.   Pedagogical content needed by teachers.

No	Pedagogical issues	Frequency (%)
a.	Curriculum and planning a lesson	37.3
b.	Teaching models/strategies	77.5
c.	Assessment	41.2
d.	Laboratory works	65.7
e.	Teaching media	75.5
f.	E-learning	59.8

Table 3.   Types of TPD expected by teachers.

No	Types of TPD	Frequency (%)
a.	Seminar	42.2
b.	Training	89.2
c.	Courses	22.5
d.	Online training	45.1

Table 4. Teachers' computer skills.

No	Computer skills	Frequency (%)
a.	Word processor	71.6
b.	Presentation (PowerPoint)	44.1
c.	Numerical and simple calculation (Excel)	34.3
d.	Graphics (Photoshop)	5.9
e.	Programming (Macromedia)	3.9
f.	No computer skills	14.7

Table 5. Teachers' internet skills.

No	Internet skills	Frequency (%)
a.	Using internet to search for information	52.0
b.	Using email	31.4
c.	Using internet in teaching	26.5
d.	Developing website/blog	9.8
e.	No skills	46.1

Sufficient computer skill is a prerequisite for participation in a web-based training program. However, there was a significant variation in teachers' computer skills (Table 4). Most teachers can use a word processor but some still do not know how to operate a computer. Our analyses of teachers' experience and their computer skills found that 25% of teachers who have been teaching for more than 14.4 years are unable to operate a computer. Jimoyiannis and Komis (2007) also found that highly experienced teachers have negative beliefs and fewer ICT skills compared with younger teachers. It is important, therefore, to improve teachers' confidence and develop their positive beliefs in the use of ICT in teaching (Hammond, Reynolds, and Ingram 2011).

We also found considerable variation in teachers' skills with using the internet (Table 5). While there are teachers who are very familiar with the internet (mainly teachers with fewer than 14.4 years' experience), there are some who have no internet skills at all. Most teachers use it to find information and communicate with others.

The fact that 46% of the participants did not know how to use the internet presented the first challenge for the research team. We decided, therefore, to provide computer and internet skills training as a pre-TPD program and we developed a learning package of basic computer skills for those participants who needed it.

Face-to-face and online training

In the second year, we developed a two-phase, dual-mode TPD consisting of face-to-face sessions and online sessions. In the first phase, conventional face-to-face sessions were conducted at each of two teacher forums to discuss three main areas – subject matter, pedagogy and ICT. The purpose of these sessions was to improve teachers' technological pedagogical content knowledge (Graham 2011; Mishra and Koehler 2006). The second face-to-face session was conducted two weeks after the first, and by the end of this session the research team had provided step-by-step guidance on how to access the training website.

Table 6. Participation in TPD.

District	Total participants	Face-to-face sessions	Online sessions
Bandung	36	36	3
Sumedang	66	31	2
Total	102	67	5

Teachers were supposed to access the resources provided in the website, which included literature on TPD such as how to conduct classroom research and write articles; reading materials on teaching strategies; teaching media; electronic learning packages; and student books (e-books). In order to identify teachers' participation, the resources were accessible only by teachers who had registered as members of the project.

Although the results of the needs assessment clearly suggested that teachers preferred online TPD, scarcely any of them took any part in the online training (Table 6). Only five teachers accessed the website and each spent less than five minutes online. This means they did not effectively participate.

To encourage teachers to participate in the online training, the research team made phone calls and sent text messages to the group leaders and some members. A number of teachers said they had had difficulty accessing the website because they had to share internet access at their schools. A small amount of money was therefore donated to the teacher forums to help them to buy additional equipment. Despite these efforts there was no improvement in the teachers' participation in online TPD. Due to this lack of participation, the research team decided to terminate the project.

Discussion

The needs assessment shows that for most teachers face-to-face participation is still a preferred mode of TPD. Even so, a number of teachers preferred online TPD (Table 3). Although the preference for online TPD is not as strong as other studies have found (e.g. Noh et al. 2004), our research suggests that a dual-mode TPD combining complementary face-to-face and online sessions should optimise results and be the best TPD model. Disappointingly, teachers' participation in the online sessions was very low (Table 6). We identified four possible explanations for this situation.

First, time arrangement and time utilisation turned out to be problems for the teachers. Although teachers are formally given one day for TPD, many could not make use of it because they were busy doing administrative tasks.

> we were very busy doing administrative tasks at our schools. Many of us are given additional tasks that are time-consuming. (Yanti)

Owston et al. (2008) similarly reported that teachers were very often unable to concentrate on their TPD due to interruptions from their colleagues and other responsibilities. Among those teachers who may have had time to participate in online TPD, some were distracted by other activities. One participant told us they were actually having a chat with other participants on social networks.

> we were online but having chat on Facebook, that actually was not necessary for us. (Siti)

Second, participants showed reduced commitment to the program because of the absence of formal consequences. It has been a long tradition in Indonesia that participation in TPD is a top-down instruction that does not require bottom-up initiatives. Everything related to a TPD program (the topics, the system, the participants, etc.) is predetermined by the government. The participants' expenditures are fully covered and extra allowance is usually provided. Attendance is regularly monitored and certain consequences are imposed on those who fail to obey the rules. The participation rate in such TPD is therefore very high. The TPD program initiated in this study is different from such government-based TPD. It is premised on teachers' needs, voluntary participation and self-financing. Therefore, commitment was a real issue for participants who did not realise that improvement in their competencies is a part of their professional status (Stigler and Hiebert 1999). Some participants clearly mentioned that they expected the research team to remind them to participate.

> you have to remind us, let's say by sending an sms [short messaging service] that we have to access and send comments. (Siti)

> sending sms and ask if Thursday [teacher forum day] I should come or access the material. (Susi)

Indeed, as suggested by Hellmig (2009), we actually contacted the participants by sending short texts or calling the group leaders, but even these tactics did not improve teacher participation. Our experience suggests that unless teachers themselves develop the motivation they will not seriously participate in the program.

Experience with previous TPD programs such as PKG (Teachers Forum) strongly suggested to us that even a successful TPD program would be unsustainable if teachers did not develop commitment and independence (Adey et al. 2004). Therefore, an important consideration for the next TPD program is to have a strategy that builds teachers' motivation. Teachers need to change themselves from being externally directed to becoming independent and self-directed.

Third, some teachers felt more comfortable with direct and personal interactions than with virtual interactions. Participation in TPD is not only a professional activity but also a social event. A teacher forum is an event for sharing professional and academic experiences and for getting to know each other and building social networks.

> difficulties that we have can be quickly solved in face-to-face training, we can help each other. (Susi)

> I feel that it is different between listening directly from the person compared to reading the material from the internet. There is a different atmosphere in face-to-face … I can ask directly to the person. (Rukaesih)

Teachers' experiences with Lesson Study, where they plan a lesson together, observe each other and discuss their observations, reinforce the importance of face-to-face sessions. An aim of Lesson Study is to build a learning community among teachers (Juanda, Liliasari, and Suhandi 2009; Lewis and Hurd 2011) through face-to-face meetings. Although many Indonesian teachers use social media such as Facebook for their social interactions, face-to-face participation seems to be a preferred TPD mode.

Fourth, a number of teachers withdrew from the program because of either their lack of computer and internet skills or inadequate supporting infrastructure (e.g. internet access). As mentioned earlier, we identified teachers who were unable to operate a computer. Despite the provision of additional training, some of these teachers remained unsure about their ICT skills. Others said that they did not participate in the online TPD because of poor internet connections.

> When I tried to access the web, it was too slow, at that time, the time we did the training. The capacity of the internet was not good enough. (Wawan)

Our study has identified the difficulty of sustaining teacher participation in TPD in Indonesia. However, recent research on teacher career pathways offers a novel alternative for early-career TPD. Fenwick and Weir (2010), for example, suggested that early professional development influences teachers' careers. With regulations requiring pre-service students to undertake professional training as a prerequisite for obtaining a teaching certificate, universities can introduce TPD to pre-service students through activities such as collaborative research with teachers. As well, universities might also encourage lecturers to offer online courses that help students become used to participating in virtual learning communities.

Facing the challenges and re-visioning future TPD

Teacher participation plays a central role in the success or failure of any TPD program. The current TPD programs in Indonesia focus mainly on improving teachers' understanding and competencies – 'the content of the TPD' – but neglect the teachers themselves. The success of a TPD program is often measured according to teachers' understanding of the content, with insufficient attention given to whether or not teachers develop the motivation to keep on learning. Even though TPD is designed for teachers, they are not treated as the subject of the program. As a result, teachers may obediently do the program as a ritual and perform well in it, but they are not really empowered. In other words, their spirit and self-consciousness for engaging in the ritual are not present. The current practice of TPD fails to ignite such spirit in these teachers' hearts.

Government policies that impose a top-down TPD and provide direct financial support also contribute to teachers' lack of independence and internal motivation. Teachers in our study perceived TPD as a government-owned project rather than as the facilitation of their professional development. The government thus unconsciously creates a bad 'habit' for teachers. As a result, teachers are unlikely to participate in TPD unless it is formally required and financial support is provided. We suggest, therefore, the existing Indonesian TPD system may contribute to the lack of sustainability in its TPD programs.

Changing teachers' habits can be difficult. Government policy on teacher education and teacher certification can influence new teachers to become professionally independent when, as certified teachers, they are required continuously to seek training (Jalal et al. 2009). In addition, rather than budgeting to support relatively small numbers of teachers in face-to-face TPD, the government can collaborate with universities and other training centres to set up dual-mode training programs that educate larger numbers more economically.

Future directions

From this analysis of the existing TPD program and related policies we recommend the Indonesian government, universities and schools create a partnership to develop TPD in the future by adopting the following three strategies:

(1) It provides teachers with:
   - incentives (e.g. promotion);
   - clear qualification standards and the pathways toward them;
   - a professional learning continuum that begins in undergraduate study and continues throughout their teaching careers.
(2) It invests in ICT infrastructure and capacity building to enable:
   - teachers' engagement in e-learning;
   - dual-mode TPD strategies that combine the benefits of both online and face-to-face learning.
(3) It encourages teacher education institutions to design in-service programs that build the capacity of their graduates to be autonomous and collaborative professional learners.

Such an ideal state may prove very difficult to achieve. Indeed, it may not be realised for many years, but it represents an aspiration that should be investigated.

Acknowledgement

Notes on contributors

Ari Widodo has been working as a lecturer at the Faculty of Mathematics and Science Education, Indonesia University of Education in Bandung, Indonesia since 1992. He has formal education backgrounds in biology education (IKIP Bandung), science, health and environment education (Deakin University) and science education (University of Kiel). His main research interests are analyses of lessons, the use of questioning in the lesson, constructivist and conceptual change and teacher professional development. He is also actively involved in government programs for improving teacher competencies.

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References

Adey, P., G. Hewitt, J. Hewitt, and N. Landau. 2004. *The Professional Development of Teachers: Practice and Theory*. Dordrecht: Kluwer Academic Publishers.
Anggraeni, D. 2010. *Pengaruh e-learning terhadap penguasaan konsep dan keterampilan proses sains siswa pada sub konsep sistem hormon di SMA* [The impact of e-learning on

students' understanding and science process skills]. Skripsi Jurusan Pendidikan Biologi FPMIPA UPI.

Ballis, A., and D. Fetscher. 2009. *E-Learning in der Hochschule: Diskurse, Didaktik, Dimensionen* [E-learning at the university: discourse, didactics, dimension]. Munich: Kopaed.

Departemen Pendidikan Nasional. 2009. *Rekap guru per status pegawai* [Number of teachers based on their employment status]. Accessed March 26, 2010. http://psdmp.kemdiknas.go.id/index.php/statistik.

Fenwick, A., and D. Weir. 2010. "The Impact of Disrupted and Disjointed Early Professional Development on Beginning Teachers." *Teacher Development* 14 (4): 501–517.

Firman, H. 2010. "Dampak program kerjasama FPMIPA UPI dan JICA [The impact of collaboration between FPMIPA UPI and JICA]." In *Teori, Paradigma, Prinsip, dan Pendekatan Pembelajaran MIPA dalam Konteks Indonesia* [Theories, Paradigms, Principles and Approaches for Mathematics and Science Teaching in Indonesian Context], edited by T. Hidayat et al., 41–54. Bandung: FPMIPA UPI.

Flint, A. S., K. Zisook, and T. R. Fisher. 2011. "Not a One-Shot Deal: Generative Professional Development among Experienced Teachers." *Teaching and Teacher Education* 27 (8): 1163–1169.

Graham, C. R. 2011. "Theoretical Considerations for Understanding Technological Pedagogical Content Knowledge (TPACK)." *Computers & Education* 57 (3): 1953–1960.

Hammond, M., L. Reynolds, and J. Ingram. 2011. "How and Why Do Student Teachers Use ICT?" *Journal of Computer Assisted Learning* 27 (3): 191–203.

Hellmig, L. 2009. "Effective Blended Professional Development for Teachers of Mathematics: Design and Evaluation of the 'UPOLA' Program." Paper presented at the Sixth Congress of the European Society for Research in Mathematics Education, Lyon, January 28–February 1.

Higgins, S., and D. Moseley. 2001. "Teachers' Thinking about Information and Communication Technology and Learning: Beliefs and Outcomes." *Teacher Development* 5 (2): 191–210.

Jalal, F., M. Samani, M. C. Chang, R. Stevenson, A. B. Ragatz, and S. D. Negara. 2009. *Teacher Certification in Indonesia: A Strategy for Teacher Quality Improvement*. Jakarta: Ministry of National Education.

Jimoyiannis, A., and V. Komis. 2007. "Examining Teachers' Belief about ICT in Education: Implications of a Teacher Preparation Programme." *Teacher Development* 11 (2): 149–173.

Juanda, E. A., Liliasari, and A. Suhandi. 2009. "The Implementation of ICT Based Lesson Study in Instructional Science to Form Learning Community of Junior High School Science Teachers and to Improve Quality of Elementary Education in West Java." In *Proceeding on 3rd International Seminar on Science Education*, edited by I. G. Rasagama, et al., 699–708. Bandung: Universitas Pendidikan Indonesia.

Kashefi, H., Z. Ismail, Y. M. Yusof, and R. A. Rahman. 2012. "Supporting Students' Mathematical Thinking in the Learning of Two-Variable Functions through Blended Learning." *Procedia – Social and Behavioral Sciences* 46: 3689–3695.

Kavadella, A., K. Tsiklakis, G. Vougiouklakis, and A. Lionarakis. 2012. "Evaluation of Blended Learning Course for Teaching Oral Radiology to Undergraduate Dental Students." *European Journal of Dental Education* 16: 88–95.

Kennedy, A., and C. Clinton. 2009. "Identifying the Professional Development Needs of Early Career Teachers in Scotland Using Nominal Group Technique." *Teacher Development* 13 (1): 29–41.

Latchem, C., and I. Jung. 2010. *Distance and Blended Learning in Asia*. New York: Routledge.

Lewis, C. C., and J. Hurd. 2011. *Lesson Study Step by Step: How Teacher Learning Communities Improve*. Portsmouth, NH: Heinemann.

Louck-Horsley, S., K. E. Stiles, S. Mundry, N. Love, and P. W. Hewson. 2010. *Designing Professional Development for Teachers of Science and Mathematics*. Thousand Oaks, CA: Corwin.

Matzat, U. 2013. "Do Blended Virtual Learning Communities Enhance Teachers' Professional Development more than Purely Virtual Ones? A Large Scale Comparison." *Computers & Education* 60 (1): 40–51.

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

Mistler-Jackson, M., and N. B. Songer. 2000. "Student Motivation and Internet Technology: Are Students Empowered to Learn Science." *International Journal of Science Education* 37 (5): 459–479.

Noh, T., J. Cha, S. Kang, and L. C. Scharmann. 2004. "Perceived Professional Needs of Korean Science Teachers Majoring in Chemical Education and their Preferences for Online and On-Site Training." *International Journal of Science Education* 26 (10): 1269–1289.

Nugraha, E. 2009. *Pengaruh e-learning terhadap kemampuan berpikir kreatif siswa SMP pada konsep pencemaran lingkungan* [The impact of e-learning on students' creative thinking skills]. Skripsi Jurusan Pendidikan Biologi FPMIPA UPI.

Olympiou, G., and Z. C. Zacharia. 2012. "Blending Physical and Virtual Manipulatives: An Effort to Improve Students' Conceptual Understanding through Science Laboratory Experimentation." *Science Education* 96 (1): 21–47.

Owston, R., H. Wideman, J. Murphy, and D. Lupshenyuk. 2008. "Blended Teacher Professional Development: A Synthesis of Three Program Evaluations." *Internet and Higher Education* 11: 201–210.

Republik Indonesia. 2005. *Undang-Undang Republik Indonesia no. 14 tahun 2005 tentang Guru dan Dosen* [Law on teachers and lecturers]. Jakarta: Republik Indonesia.

Riandi, N., Rustaman, O. S. Santoso, and Liliasari. 2009. "Pengembangan perkuliahan berbasis TIK GeneTik untuk meningkatkan kebermaknaan belajar mahasiswa biologi [Developing ICT-based lessons to improve students' meaningful learning in genetics course]." *Jurnal Pengajaran MIPA* 14 (2): 23–36.

Saito, E., I. Harun, I. Kuboki, and H. Tachibana. 2006. "Indonesian Lesson Study in Practice: Case Study of Indonesian Mathematics and Science Teacher Education Project." *Journal of In-Service Education* 32 (2): 171–184.

Sorensen, P., J. Twidle, A. Childs, and J. Godwin. 2007. "The Use of Internet in Science Teaching: A Longitudinal Study of Developments in Use by Student-Teachers in England." *International Journal of Science Education* 29 (13): 1605–1627.

Stigler, J. W., and J. Hiebert. 1999. *The Teaching Gap*. New York: The Free Press.

Suhendi. 2009. *Implementasi e-learning untuk meningkatkan penguasaan konsep dan memperbaiki sikap belajar mahasiswa pada materi pencemaran lingkungan* [The use of e-learning to facilitate students' understanding and attitude on learning]. Tesis Sekolah Pascasarjana UPI.

Universitas Pendidikan Indonesia. 2010. *Re-design pendidikan professional guru* [The re-design of professional teacher education]. Bandung: UPI Press.

Watson, R., and A. Manning. 2008. "Factors Influencing the Transformation of New Teaching Approaches from a Programme of Professional Development to the Classroom." *International Journal of Science Education* 30 (5): 689–709.

Widodo, A. 2008. Science Education Research in Indonesia: The Case of UPI. Paper presented at the Second International Seminar on Science Education, October 18, Bandung, Indonesia.

Widodo, A., Riandi, Amprasto, and A. R. Wulan. 2006. *Analyses of the Impact of Teachers' Professional Development Programs on the Improvement of Teachers' Teaching Practice*. A research report on educational policy. Indonesia University of Education.

Widodo, A., P. Irfan, M. Ihsanudin, and C. Warianto. 2010. "Facilitating Teachers' Professional Development through Lesson Study: Insight from Two Years Lesson Study at SMP Tunas Agro." Paper presented at the Third International Conference on Lesson Study, August 7, Bandung, Indonesia

Wu, J. H., R. D. Tennyson, and T. L. Hsia. 2010. "A Study of Student Satisfaction in a Blended E-learning System Environment." *Computers & Education* 55: 155–164.

Yumuk, A. 2002. "Letting Go of Control to the Learners: The Role of Internet in Promoting a More Autonomous View of Learning in an Academic Translation Course." *Educational Research* 44 (2): 141–156.