Do blended virtual learning communities enhance teachers' professional development more than purely virtual ones? A large scale empirical comparison

Highlights

- Analysis of 26 online communities (OLCs) for professional development of 1492 teachers
- 'Average' teacher improves at least somewhat teaching skills & school subject knowledge
- Room for improvement of communities; some communities function better than others
- Communities with high embeddedness in offline social networks provide more benefits
- Complete integration online & offline relations unnecessary; scale up of OLC use possible

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Do blended virtual learning communities enhance teachers' professional development more than purely virtual ones? A large scale empirical comparison

This article examines whether a mixture of virtual and real-life interaction—in contrast to purely virtual interaction—among some members of online communities for teachers is beneficial for all teachers' professional development in the whole community. Earlier research indicated that blended communities tend to face fewer trust and free rider problems. This study continues this stream of research by examining whether blended communities provide more practical benefits to teachers, both in terms of perceived improvements to their teaching capabilities as well as for their substantial understanding of their core topic. In addition, it is tested whether blended communities provide more information about vacancies, as teachers' mobility is regarded as too low in the EU. The analysis uses survey data from 26 online communities for secondary education teachers in The Netherlands. The communities are part of a virtual organization that hosts communities for teachers' professional development. The findings indeed show beneficial effects of blended communities. Moreover, the results modify earlier claims about the integration of online communication with offline interaction by showing that complete integration is unnecessary. This facilitates a scaling up of the use of online communities for teachers' professional development.

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1. Introduction

Online and blended learning is likely to become a substantial component of the US education system, at least at the secondary level (Picciano et al., in press; Shea & Bidjerano, 2010). Concerns about teachers' competencies in this area, however, remain (Picciano et al., in press). In general, teachers' professional development is an issue that has received much attention among educational researchers and practitioners because it is regarded as an important input for students' learning success (Kao & Tsai, 2009). Many regard (offline) professional learning communities as one important way to support effective professional development, but there is no hard evidence about their usefulness (Bausmith & Barry, 2011). On the other hand, there are several examples of effective professional development, for instance through computerized professional development tools, collaborative teaching practices (for instance in Second Life), or blended courses (Donguk, 2010; El-Deghaidy & Nouby, 2008; Fisher et al, 2010; Yeh, Huan, & Yeh, 2011). This article focuses on the use of informal online learning communities for the professional development of teachers. Whereas research on the effects of virtual learning environments on student learning has shown some progress (Means et al, 2009; Shea & Bidjerano, 2010), there is less convincing evidence on the effects of so-called online communities of practice for teachers (Dede et al., 2009). Online learning communities differ from online or blended courses in a number of ways. They can and typically are much larger and they do not have a specific schedule. In addition, their success is dependent on the voluntary engagement of their members to share their knowledge and experiences (Kling & Courtright, 2003; Lin, Lin, & Huang, 2008; Schlager & Fusco, 2003). While research on online communities (OLCs) of students has in some cases used experimental research, empirical studies that focus on OLCs for the professional development of teachers are mainly based on case studies or other designs that leave room for speculation about the generalizability of the findings. Some studies report on promising exemplary cases of OLCs for teachers (Duncan-Howell, 2010; MacDonald & Poniatowska, 2011;

Motteram, 2006; Tsai, Laffey, & Hanuscini, 2010), whereas other research points to trials that did not meet their ambitions (Chen, Chen, & Tsai, 2009; Yang & Liu, 2004; Kling & Courtright, 2003) and it is hard to get a handle on the conditions under which cases are a success.

MacDonald and Poniatowska (2011) argue that insufficient activity of members of online learning communities is an issue that deserves more attention. In the general literature about online communities there is a similar discussion about a lack of active involvement of members. In this literature the problem of passive membership is framed as a "free rider problem" (Kollock, 1999). Lin, Lin and Huang (2008) found that even in a study of online learning communities for teachers with not more than ten members, free riding phenomena emerged. While research on virtual communities for student learning analyzed the effects of blended learning (e.g., see Shea & Bidjerano, 2010), research on online communities for teachers' professional development did not yet take up the potential of blended communities intensively. Recently, Matzat (2010) compared 26 OLCs designed for the professional development of Dutch teachers. He concludes that blended communities, when compared to purely virtual communities, tend to have more active members. However, this leaves open the question whether blended communities also provide more, if any, benefits for the professional development of teachers.

Dede et al. (2009), in a review of about 400 studies on online teacher professional development, come to the conclusion that research in this field often relies on anecdotal evidence and could profit from more rigorous methodologies. They posit a research agenda, arguing that research should not only find out whether some specific design elements do work, but also why they work (ibid.: 13). The study presented here aims at contributing to this agenda by answering the following research questions. Do blended online communities provide more benefits for the professional development of teachers than purely virtual ones? Three benefits are analyzed, namely perceived improvement for

teaching capabilities, substantial understanding of teachers' core topic, and the provision of information about vacancies, as teachers' mobility is regarded as too low in the EU (Council of the European Union, 2011). Moreover, if there are more benefits in blended communities, how and why do they emerge? Finally, the article contributes to modifying an existing claim about the need for an integration of online interaction with face-to-face meetings. Some researchers have proposed to build online communities around pre-existing offline communities (Kling & Courtright, 2003; Barab, MaKinster, & Scheckler, 2003), thereby suggesting a *complete* integration of online with offline activities. The results presented here indicate that integration of online and offline activities is beneficial for teachers' communities. However, in addition, they show that a mixture of virtual and 'real-life' interaction between *some* members is enough to provide more benefits to teachers in the *whole* community, making a complete integration unnecessary. This is of outmost importance for educational policy makers who aim at scaling up the use of online learning communities for teachers' professional development (Liebermann & Pointer Mace, 2010).

The article is structured as follows. First, I describe the theoretical background of the article. I explain the role that an integration of some community members' offline and online interaction plays for the whole community, leading to five hypotheses about potential benefits of blended online communities for teachers. I describe the research design and measurements which rest on large scale survey data of teachers of 26 online communities. This is followed by some descriptive results that show to what extent teachers perceive that benefits are provided to them. Next, I present the results of the hypotheses testing, followed by a summary and discussion of the implications of the results for the design and management of online communities for teachers' professional development.

2. Theoretical Background

2.1 Blended student communities versus embeddedness of teachers' online communities in offline social networks

In blended online communities for students the integration of offline with online interaction has shown to be a promising strategy that facilitates learning (Shea & Bidjerano, 2010). Even among somewhat older Internet users (above 45) blended groups have shown to be useful for learning (Chu & Chu, 2010). There are, however, important differences between blended communities for students versus communities for teachers. For student communities, reaching a high degree of integration usually is not difficult because students are often obliged to follow courses for which some face-to-face course meetings are standard (Motteram, 2006). This is different for online communities for the professional development of teachers. Many participating teachers have a considerable number of years of teaching experience. They are in different schools distributed over the whole country. Some teachers may know each other because they teach, or have taught for some periods of their career, at the same school or are active in the same union or party. At least during the early phases of an OLC for teachers, however, the degree of integration of offline with online interaction is likely to be much lower than in communities for students. Nevertheless, integration is possible and may increase in the long run for a number of reasons. First, some online communities for teachers are naturally affiliated with already existing offline communities. For instance, Kling and Courtright (2003) present examples of online communities that have been built around teachers of the same schools. These teachers formed a community with regular face-to-face meetings. Second, much research has shown that discussions in online communities with common interests can lead to offline contacts between members (Best & Krueger, 2006; Matzat, 2004; Parks, 1996; Zhao, 2006) and teachers appreciate making contacts to peers outside their own working place (Duncan-Howell, 2010). Finally, managers of online communities can make active efforts to increase the integration. For instance, in a study of online health care communities, Dannecker and Lechner (2007) showed that managers and members

actively created opportunities for offline interaction that members regularly used. Some managers of the focal Dutch online communities for teachers followed the same strategy by offering face-to-face meetings among their members. Integration of online with offline interaction may thus take place in online communities for teachers, although the resulting degree of integration may be much lower than in student communities, where almost all students may know each other. Instead of using the term 'blended community' for teachers' communities I therefore speak of a high(er) degree of embeddedness of online interaction in offline networks: the informal network of offline relations between members of an online community has a high(er) density (Granovetter, 1985). Density refers to the proportion of existing offline relations among OLC members when all potential offline relations are considered. An example of an OLC with a high embeddedness could be a group of teachers who interact face-to-face at a school and then create an OLC which others join. It could also be an OLC that subsequently integrates face-to-face interaction. What comes first, offline or online interaction, does not matter, as long as many of the potential offline relations indeed exist. A higher embeddedness does not rule out that a considerable number of members do not know anybody offline. The crucial question for field researchers and policy makers who consider extending the use of online communities for teachers' professional development on a larger scale is whether those teachers who do not interact outside the OLC with any other members will nevertheless, in the long run, be affected by the common offline interaction of others.

2.2 Barriers for online learning communities to reach their full potential

There are two typical problems to a successful interaction in teachers' online communities. First, MacDonald and Poniatowska (2011) indicate that a lack of active membership contributions to online discussions often constitutes a problem. Every member profits from the discussion (independent of one's own contribution intensity) because the discussion 'consumption' is non-

excludable (Kollock, 1999). A useful contribution to a discussion or a common database is costly. At the very least, it takes time and effort. While the contribution costs are carried by the contributing members, the discussion benefits are available to all members. *Free riding* is the tendency of members to withhold information and let others incur the contribution costs (McLure Wasko & Faraj, 2000). If the tendency to free ride is too high, there is hardly any discussion and members do not gain enough benefits (Lin, Lin & Huang, 2008). Second, a *lack of trust* may inhibit communication between teachers in online communities (Kling & Courtright, 2003). Teachers take some risks by putting teaching examples online. In the traditional classroom setting, teachers keep their teaching materials private after closing the classroom door. In online communities of teachers the members do not know where their material will travel after they have put them on the Internet (Barab et al., 2003). If problems of trust between teachers are too severe, they hesitate to share their knowledge, and the community fails (Kling & Courtright, 2003; Riding, Gefen & Arinze, 2002).

2.3 Effects of the embeddedness of online communities in offline networks: earlier research and new hypotheses

There is not a lot of empirical evidence showing how the integration of online with offline interaction affects the outcomes of online interaction. Experimental and quasi-experimental research on student online communities indicates that blended communities tend to provide better learning outcomes than traditional face-to-face classes if appropriate technology is used and high enough teacher-student interaction takes place (Shea & Bidjerano, 2010; Zhao et al., 2005). These findings, however, are difficult to translate to online communities for the professional development of teachers. In such cases, no instructor-student interaction takes place and learning outcomes are less well-defined. Experimental research on computer-mediated communication in small groups shows that communication between members increases trust, and preceding communication between

members increases the rate of active discussion contributions, thereby reducing free rider problems (Riegelsberger, Sasse, & McCarthy, 2003). Much less field research has been conducted on the effects of communication between members of large or longer-lasting online communities. The situation in large communities is obviously different from interaction in small online groups. First, one cannot expect all members in large communities to communicate with one another. Members in large communities may wish to share their knowledge even if they do not know each other at all. Second, in longer-lasting communities, the consequences of communication (even among those members who have communicated with one another) might be weaker because the time lag between the preceding communication and the subsequent online interaction can be large (Matzat, 2010). Researchers who study large online communities therefore tend to use theories that are easily applicable to large group communication. I next focus on mechanisms that reveal how embeddedness in offline networks changes the situation for the whole group and may thereby influence outcomes in online communities of teachers for all members.

The literature on knowledge sharing groups discusses the relevance of face-to-face relationships between members (Wenger, 1998; Brown & Duguid, 1991). However, it does not clarify how characteristics of the network as a whole can affect online interaction. Also, online community researchers have wondered whether face-to-face meetings are necessary (e.g., Johnson, 2001). Some argue that the greatest potential for online communities of practice is to function as a supplement to already existing local offline communities (Schlager & Fusco, 2003; Kling & Courtright, 2003). Barab et al. (2003) even describe face-to-face interaction as an *essential supplement* to online interaction. I agree with these authors that online communities of practice have the potential to support pre-existing local communities. However, I argue that online communities of practice also have potential beyond this support function. The authors neglect the fact that offline interaction of some members may change the situational constraints not only for those members who know each

other, but also for the whole group. Understood in this sense, the perspective that is presented here implies that face-to-face (or offline) interaction is not an essential pre-condition for a member changing his behavior. It is enough for some other members to interact offline. Therefore, online communities can include individuals who are not members of a pre-existing local community as long as other members interact face-to-face.

According to social network analysts, embeddedness in networks changes online relations and online interaction (e.g., Wellman & Gulia, 1999). Coleman (1988; 1990) has argued that dense networks diminish problems of cooperation in groups in a number of ways. Cheating is more disadvantageous because individuals who do so damage their reputations. Information about cheating behavior can more easily spread in a higher density network (see also Raub & Weesie, 1990). Moreover, cooperative norms and expectations of trust are easier to establish because norm violators face a higher likelihood of being sanctioned through other members' coordinated action, as facilitated by the dense network. These and related arguments by Granovetter (1985) stimulated a large body of research exemplifying how dense networks -or, in the terminology of Granovetter (1985), the embeddedness of action in social networks- facilitate solutions to problems of collaboration in the offline world.

Field research on large online communities provides evidence for some effects of embeddedness in offline networks. Matzat (2009) found that in academic emailing lists embeddedness in offline networks provides incentives for researchers to gain reputation within their scientific community by contributing actively to the online discussion. Therefore, embeddedness can increase the quantity of the online discussion contributions because it provides selective incentives (namely opportunities to gain or lose reputation), thus reducing *free rider problems* in the sense that one can expect more members to feel that the benefits of contributing outweigh the costs (Matzat, 2009). At the same

time, in emailing lists with a higher embeddedness researchers tend to receive less off-topic emails and evaluate the quality of the email contents as higher (Matzat, 2009c). Accordingly, embeddedness tends to increase the quantity of discussion contributions, but the increase does not come at the cost of an information overload or reduced content quality.

Furthermore, Matzat (2009b) argues that there are other reasons to expect embeddedness to affect online interaction. Even if some members do not have any offline contacts, they recognize over time that the informal network among members is dense. They realize that information about misbehavior spreads quickly and that strong forms of misbehavior may be sanctioned by collective action (e.g., coordinated public complaints) that is facilitated by dense informal relationships. Under such conditions, members are more dependent on one another to gain reputation and avoid disapproval. If members are more interdependent, then they are more likely to develop an interest in maintaining a satisfying relationship with one another (Homans, 1961; Lindenberg, 1997).

Under conditions of high social embeddedness and therefore relational interests between members, problems of trust are also diminished because of the following reasons. The abuse of placed trust would be a clear signal of a lack of relational interest. In OLCs with relational interests signaling a lack of relational interests is self-damaging for a member because members expect others to take into account the relationships. Signaling a lack of relational interests is offending to other members. Therefore, under a high degree of embeddedness and relational interests, trust is less likely to be abused and members are more likely to behave cooperatively. Members in OLCs with high embeddedness anticipate the higher likelihood of cooperative behavior from others. Therefore, it is likewise more likely that members will place their trust in other members of the OLC (Matzat, 2009b). Hence, there fewer problems of trust will arise. Matzat (2010), in a study of online communities of teachers, found support for these arguments. He showed that the higher the

embeddedness the less intense problems of trust and the less likely the tendency to free-ride. More concretely, in highly embedded communities this means that teachers tended to share their teaching material more often, were more often writing about their problems at work, and became more active during online discussions (Matzat, 2010). In other words, in embedded communities there are *more opportunities* for teachers to profit from the OLCs for their professional development.

I argue that teachers use these opportunities to improve their teaching skills and to learn from each other about their core school topic. In this study I thus test the assumption that embeddedness in offline networks not only leads to a reduction of problems of trust and free-riding but the stronger claim that embeddedness leads to improvements with respect to teachers' teaching skills and their substantive knowledge about their school subject because teachers use the opportunities. Furthermore, in the European Union teacher mobility is very low, and the education policy of the European Commission and the European Council explicitly promote teachers' mobility as a part of a teacher's professional development (e.g., Council of the European Union, 2011; European Commission, 2010: 15). With respect to teachers in The Netherlands, policy advisors argue that mobility could be increased by simply offering teachers more adequate vacancies (Stamet, 2011). I therefore examine to what extent the Dutch teachers' OLCs fulfill this function and argue that teachers in embedded communities use the opportunities to receive more information about vacancies. With the following hypotheses, it is tested whether teachers use the opportunities.

Hypothesis 1: In online communities for teachers, the higher the degree of embeddedness in offline networks the more teachers improve their teaching skills.

Hypothesis 2: In online communities for teachers, the higher the degree of embeddedness in offline networks the more teachers improve their knowledge about their school subject.

Hypothesis 3: In online communities for teachers, the higher the degree of embeddedness in offline networks the more often teachers receive information about vacancies.

On a more general level and in line with the findings in academic emailing list (Matzat, 2009c), I argue that a higher degree of embeddedness provides incentives to teachers to become more active during online discussions and to invest more effort in writing discussion contributions that fit with the needs of their colleagues. These arguments are tested with the following two hypotheses.

Hypothesis 4: In online communities for teachers, the higher the degree of embeddedness in offline networks the more teachers are satisfied with the quantity of the material offered by their peers.

Hypothesis 5: In online communities for teachers, the higher the degree of embeddedness in offline networks the more teachers are satisfied with the quality of the material offered by their peers.

The hypotheses are tested in multivariate analyses, controlling for other factors that may affect aspects of satisfaction with the community, such as the user's gender, age, digital skills, trusting disposition, length of membership, frequency of passive community use, intensity of active use of the community, and size of the community.

3. Study design, measurements, and methods of data analyses

The hypotheses were tested with questionnaire data that was collected between November 2005 and February 2006 from 33 online communities of practice in a large Dutch virtual organization for teachers of secondary education. A random sample of members received an email invitation for a

web survey (total n=2,583, response rate 37.8%). The items needed for testing hypothesis 4 and hypothesis 5 were presented in a randomized fashion only to half of the respondents to reduce questionnaire length. All teacher communities worked in the same technological environment. This environment included discussion fora, an electronic newsletter, and opportunities for uploading and downloading teaching material.

3.1 Independent variables

Embeddedness of an OLC is measured indirectly, by a proxy, as proposed in earlier work (Matzat, 2009). The measurement procedure is exactly the same as in the study of Matzat (2010), but briefly explained for the sake of clarity. Experienced community members (=membership of 2 years or longer) had to assess the degree of embeddedness of their own community by giving answers to some items. As a characteristic of the community, embeddedness (i.e., the resulting score) should have significant variation among the OLCs, however, direct measurement using four items about the amount of offline communication among members led to a scale with high reliability (alpha=.90), but no discrimination between the communities (F=1.0, df_1=24, df_2=106, p=0.47). Measurement thus had to proceed in an indirect way. First, for every OLC the extent to which the respective group of teachers constituted a community that shared many activities and interests in common was measured, as described below. Second, it is demonstrated that this score was associated with items that directly measured interaction among members outside the community.

For the first step, embeddedness was measured indirectly with the help of an unfolding scale analysis (van Schuur & Kiers 1994) of three 6-point Likert-scale items, which resulted in a Mudfold scale. A Mudfold scale is similar to the well-known Guttman scale, with the exception that the Mudfold scale allows some deviations from the "perfect answer pattern" of the Guttman scale. In a Mudfold scale, a

number of items and persons can be ordered one-dimensionally with regard to a latent trait -in this case, the perceived degree to which a group constitutes a community that shares many activities and interests in common. The following three items were presented to experienced OLC members only (those who subscribed for more than two years), with the prefatory question "To what extent do you agree with the following statements about your own community?" (answers ranged from *completely disagree* to *completely agree*).

a) It is a set of groups and cliques with their own interests and activities that do not have much in common as a community.

b) It is a set of groups and cliques with their own interests and activities that also have some common interests as a community.

c) It is a moderately integrated community that shares some interests and some activities.

Analysis resulted in a strong Mudfold scale consisting of the items in the order a-b-c (H=0.86, assumptions of an unfolding scale met). In addition, it discriminated among the communities (11% of variance between groups, F=1.52, df_1=25, df_2=314, p=0.05). Because embeddedness is a characteristic of the whole OLC, the arithmetic mean of the members' answers for every community was taken as the indicator of embeddedness.

The assumption underlying the measurement procedure is that the more the group of teachers constitute a community that shares activities and interests in common, the higher the degree of embeddedness. In this case, embeddedness consists of the frequency of the members' interaction outside the OLC. The ordering of the OLCs, according to the scale scores of embeddedness, can be externally validated in a meaningful way, providing evidence for the assumption that the scale captures offline communication between members. In OLCs that score higher on the embeddedness scale, there are more members having contact with one another outside the community than in OLCs

that score lower on the scale. When respondents agreed that "there are groups of members who regularly meet each other in face-to-face membership meetings," they tended to be in OLCs that scored significantly higher on the embeddedness scale (t=2.6, df=221.1, p=.01). The measurements of other independent variables are briefly described in Table 1.

(Table 1 here)

3.2 Dependent variables

Improvement of teaching skills is measured by taking the arithmetic mean of the following two items (answer options on 7-point Likert scales ranged from *completely disagree* to *completely agree,* r=.49. p<.01): *The information of the teachers' community improves my teaching skills sometimes quite a bit* and *In the teachers' community I often find solutions to teaching problems*. The indicator of *improvement of knowledge about the school subject* was constructed by taking the arithmetic mean of the following two 6-point Likert scaled items (answer options labeled as *never-seldom-sometimes-often-very often-always,* r=.72, p<.01): *How often do you receive useful information about new developments in your school subject via the teachers' community?* and *How often do you improve your knowledge about your teaching subject via the teachers' community?*. *Reception of information about vacancies* was measured with the following 6-point Likert scaled item. *How often do you receive useful information about new vacancies in the teachers' community?*[1] The variable *satisfaction with the quantity of the material* was composed of the 7-point Likert scale *How do you evaluate the quantity of the teaching material and information about your school subject that is offered in the teachers' community?* Because of the skewed distribution I dichotomized the variable into the categories *good* (=1, 55% of answers) versus all other answers (=0) including the two

[1] I used a transformed variable to reduce heteroscedasticity, a so-called Box-Cox transformation $\{Y'=(Y^{\lambda}-1)/\lambda\}$, with $\lambda=0.99$ (Hamilton 2004). The conclusions, however, do not change when the original variable is used.

extreme labels *too small* and *too large*.[2] The index of thesatisfaction with the quality of the material consists of answers on a 7-point Likert scale *How do you evaluate the quality of the teaching material and information about your school subject that is offered in the teachers' community?* Answers ranged from *very small* to *very high.*

The hypothesis testing has to take into account the potential interdependence of errors because the teachers are clustered within communities. Accordingly, the adequate method of data analyses consists of multilevel versions of multiple linear and logistic regression analyses, applying maximum likelihood estimators (Bryk & Raudenbush, 1992; Leckie, 2010a; Leckie 2010b).

4. Results: Descriptive findings

A first group of respondents consisted of students who were still in their education phase, some others were part-time teachers who mainly had another profession (<= 20% of a position as a teacher), and a third group consisted of individuals who were not teaching at all, but were interested in the educational world for other professional reasons. Among them were employees in the educational book sector, librarians, etc. These respondents were removed. In seven teachers communities there were not enough experienced members to answer the items about embeddedness. These communities had to be removed for the multivariate data analyses, as well as respondents with any missing value in the used items, eventually leaving us with 1,492 teachers in 26 communities. The sample size used for the multivariate analyses consists of these 1,492 teachers for testing the first three hypotheses, and answers from 725 teachers are used for testing the last two hypotheses. The teachers differ with respect to their school subjects; they teach in subjects such as physics, chemistry, mathematics, literature, languages, history, social science, and others. Every online

[2] Other transformations of the variable do not change the conclusions (see results).

community was specialized in the discussion of one specific school subject so that all members of the same community were teaching the same subject.

Out of all 1,492 teachers, the "average member" has subscribed for 7 to 12 months, uses the community 1.7 days per week, and is not very active in the community ($\bar{X}$ =2.4 on a scale from 1 to 7). About 7% of respondents have contributed to the electronic newsletter; 16% reported having sent some teaching material to the community, and 7.2% attended at least one face-to-face meeting of OLC members organized by the management of the community. Fifty-six percent of respondents are women, and the median age is 46 years. Size of the 26 OLCs varies from 95 to 3682 members (see appendix for additional information and correlations).

The OLCs as ordered according to their degree of embeddedness differ with respect to their members' density of offline relations. The following data clarify to what extent the difference between highly and weakly embedded OLCs captures differences in the amount of offline relations. The respondents were asked to agree or disagree with three items, as prefaced by "In our community there are groups of members who…": “a) are in regular contact with each other outside of the community”, “b) meet with each other regularly at face-to-face membership meetings”, and “c) call each other regularly." The median embeddedness score was taken as a cut-point, and the two resulting clusters of communities (weakly versus highly embedded OLCs) were compared with respect to the average proportion of members who agreed with the aforementioned items. For the three items, the proportion of agreeing members grew from 28% to 41%, 18% to 33%, and 11% to 19%, respectively. Thus, in OLCs with higher embeddedness scores, more members perceive others to be interacting face-to-face or via telephone.

The distributions of the benefits provided by the teachers' communities show that, on average, teachers profit somewhat from their community; in addition they show that there is a considerable amount of variation among teachers in the perception of benefits, as Table 2 indicates.

(Table 2 here)

55% of the teachers regard the quantity of offered information and teaching materials as 'good', 40% evaluate it –to varying degrees- as too little and only 5% –to varying degrees- as too large. For the evaluation of the quality of offered information and teaching materials 45% have chosen the middle category –neither high nor low; 32% regard the quality to varying degrees as 'low', and 23% regard it to varying degrees as 'high'. The teachers are somewhat critical with respect to the evaluation of teaching benefits. 46% of the teachers more or less disagreed (score <=3 on a 7-point scale) to the items indicating that they receive teaching benefits; only 19% agreed, and 35% of the teachers neither agree nor disagree (scores between 3.5 and 4.5). A closer look at the two items revealed that 67% disagreed to the item that they would *often* find solutions to teaching problems in the community whereas only 31% disagreed to the items that they would *sometimes* quite a bit improve their teaching skills through the community. I conclude that there are some benefits with respect to teaching skills for the majority of teachers, but these benefits do not appear often. The distribution of the knowledge benefits with respect to the teachers' school subject shows that almost half of the teachers (49%) tend to disagree with the items indicating the reception of benefits (score <=3), 14.5% neither agree nor disagree (score=3.5) while 36.5% tend to agree. Finally, only some teachers receive information about vacancies. 17% report that they would never receive useful information about vacancies from other colleagues within their community, 12% have chosen the option 'seldom', 34% sometimes, 23% often, 10% very often and only 3% have chosen the option always. T-tests show that the arithmetic means of all five scale scores differ significantly (all five p-values <.01) from the minimum scale value of 'one' that would indicate no benefits at all. The teachers thus

tend to profit somewhat from their community although there is considerable variation in the extent of profiting and many gain only very few, if any, advantages.

Table 3 describes to what extent there is variation in the scores of the five original items between the communities. The intra-class correlation is the proportion of the total amount of variance that is between the communities.

(Table 3 here)

Table 3 shows that there is a moderate amount of variation between the communities. The proportion of variation between the communities is the highest with respect to the school subject benefits, namely 10%. It is the lowest for the benefits with respect to teaching benefits, namely 4%. For all five indicators the amount of variance between the communities differs significantly from zero, as all Likelihood-ratio tests show (for all five chi-square values: $p < .01$). This indicates that there are significant differences between the teachers' communities with respect to the benefits that they provide to the teachers.

5. Results of the hypothesis testing

In the following the results of multivariate linear and logistic 2-level regression analyses are presented. All models control for the effects of a number of other factors of influence that may affect the (perception of) received benefits. Model 1 controls for the size of the community and a number of other characteristics of the teacher. Model 2, in addition, controls for the teacher's trusting disposition, the length of membership in the community, the frequency of its use, and the degree of the teacher's active contribution to community discussions. Table 4 shows the results of the tests of Hypothesis 1 about the improvement of teaching skills. The effect of embeddedness in offline networks is positive and significant. The higher the degree of embeddedness of the community the

more the teachers tend to improve their teaching skills. The results provide support for the first hypothesis. In addition, teachers with more digital skills tend to profit more from their community with respect to teaching skills and those who more often give socially desirable answers also tend to profit more from the community. The last finding indicates that the respondents' answers might be affected by a tendency to give socially desirable answers. Model 1 explains 37.5% of the variance between the community, as a comparison between Table 3 and Table 4 shows [(0.08-0.05/0.08)=0.375]. Model 2 indicates that those members who use the community more often, who are more active during knowledge sharing activities in the community, who are more trusting, and those who are for a longer time a member profit more from their community with respect to teaching skills.

(Table 4 here)

Table 5 provides the results of the tests of Hypothesis 2 about improvements in the teacher's knowledge about the school subject. The effect of embeddedness is in both models positive and significant, providing support for Hypothesis 2. The higher the embeddedness of the community in offline networks the more the teachers tend to improve their knowledge about the school subject.

(Table 5 here)

Furthermore, female teachers, teachers who have more digital skills, and teachers with less digital experience tend to profit more from their community with respect to their knowledge about their school subject. In addition, those teachers who use the community more often, who are more active during knowledge sharing activities in the community, who are more trusting, and those who are for a longer time a member profit more from their community with respect to their knowledge of their school subject. Model 1 explains about 35.7% of the variance between the communities. Table 6 shows the results of the tests of Hypothesis 3 about the reception of information about vacancies.

(Table 6 here)

First, the effect of embeddedness is positive and significant, thereby providing support for Hypothesis 3. In communities with a higher degree of embeddedness teachers tend to receive more information about vacancies. Furthermore, teachers with better digital skills and female teachers tend to profit more from their community with respect to the reception of information about vacancies. Model 1 explains about 44.4% of the variance between the communities. Moreover, those teachers who use the community more often, who are more active during knowledge sharing activities in the community, who are more trusting, and those who are for a longer time a member profit more from their community with respect to the reception of information about vacancies. Table 7 provides the results of the tests of Hypothesis 4 about the satisfaction with the quantity of the material.

(Table 7 here)

We see that both models cannot explain differences in the satisfaction with the quantity of the material in a reasonable manner. The effect of embeddedness is positive, but not significant, thus providing no support for Hypothesis 4. Table 8 shows the results of the tests of Hypothesis 5 about the satisfaction with the quality of the material. The effect of embeddedness is positive, but non-significant, thus providing no support for Hypothesis 5. In addition, the older the teacher the lower the satisfaction with the quality of the material offered by the peers. Furthermore, those teachers who use the community more often, who are more active during knowledge sharing activities in the community, who are more trusting, and those who are for a longer time a member tend to be more satisfied with the quality of the offered material.

(Table 8 here)

As a summary, the multivariate data analyses provide support for the first three hypotheses about the effects of embeddedness on the improvement of teaching skills, the improvement of knowledge about the school subject, and the reception of information about vacancies. There is no support for the hypotheses about effects of embeddedness on the quantity and quality of the knowledge sharing

activities. Moreover, female teachers tend to profit more from their community with respect to their knowledge about their school subject and they tend to receive more often information about vacancies that is useful to them. Finally, those teachers who are more intensive and more active members, who are more trusting, and those teachers who are member for a longer time tend to profit more. The last mentioned finding comes as no surprise because here causality can run in both directions. Communities that provide more benefits may motivate their members to visit the community more frequently, to become more active in it, to become more trusting, and may prevent that their members leave the community. The remarkable finding is that the effects of embeddedness remain stable in all five tests across Model 1 and Model 2, meaning that the effect of embeddedness cannot be "explained away" by other factors that indicate members' usage intensity. Furthermore, as additional regression analyses indicate (see Appendix 2), a high embeddedness increases all members' benefits independent of whether they participated in any face-to-face membership meetings. Those members who did not participate profit from a high embeddedness in offline networks just like those who participated. Furthermore, community size does not affect any of the five outcome variables, meaning that even in large communities teachers profit from the use of the community with respect to their teaching skills, their professional knowledge, and the reception of information about vacancies.

6. Summary, discussion, and implications of the results

This article examines whether blended online communities for teachers' professional development provide more benefits to teachers than purely virtual ones. The term 'blended community' has a slightly different meaning for communities of teachers versus students. Whereas in blended communities of students most students may know each other from obligatory face-to-face course meetings, in blended communities of teachers only some members may know each other from

interaction outside the community. This is called the embeddedness of the online community in offline networks. The important question for approaches that aim at scaling up the use of online learning communities for teachers' professional development (Liebermann & Pointer Mace, 2010) is whether in large communities of teachers all members may profit from a high embeddedness independently of their own involvement in offline activities. Earlier research indicated that blended online communities of teachers face less free-riding and fewer problems of trust, both of which provide important barriers for online communities to reach their full potential (Matzat, 2010). In this study it is additionally tested whether online communities that are characterized by a mixture of virtual and face-to-face interaction among some members help teachers more in improving their teaching skills, improving their knowledge about their school subject, and receiving information about vacancies. The provision of vacancies is regarded as important for increasing the rather low teacher mobility in the EU (European Commission, 2010; Stamet, 2011). Furthermore, it is tested whether teachers in embedded communities are more satisfied with the quantity and the quality of the knowledge exchange.

The hypotheses were tested with data of 26 online communities for the professional development of Dutch teachers of secondary education. Data analyses indicate that the teachers tend to improve their teaching skills, they tend to improve their knowledge of their school subject, and they tend to receive at least some information about vacancies through using their online community. 55% of the teachers are satisfied with the quantity of the knowledge exchange and only 32% regard the quality as more or less too low. Moreover, there is a substantial amount of variation among the 26 communities with respect to the teachers' satisfaction. The results of the multivariate data analyses support the first three hypotheses about beneficial effects of embeddedness in offline networks on the improvement of teaching skills, the improvement of knowledge about the school subject, and the reception of

information about vacancies. The effects, however, were non-significant with respect to the satisfaction with the quality and quantity of the knowledge exchange.

What do we learn from these findings? First of all, the results show that a high embeddedness not only reduces free-riding and problems of trust, as indicated by Matzat (2010). In addition, the results demonstrate that a high embeddedness increases the practical benefits that the online community provides to teachers. Teachers profit from their colleagues' more intensive discussion contributions and sharing of material. This is true even in large communities where many members may not know any other member.

Under a high embeddedness teachers are more willing to trust each other, they are more motivated to share teaching material and engage in useful discussions. Nevertheless, this does not lead to an increase in the satisfaction with the quality and quantity of the online knowledge sharing. For this unexpected finding I offer the following tentative explanations. It might be that under a high degree of embeddedness teachers are more motivated to engage during online discussions and to share their teaching material and experience, just like the theory argues (see Matzat, 2010). However, this may not necessary lead to a higher total number of messages sent to the community. An administrator who realizes that 'his' or 'her' community members are becoming more active may decide to reduce the own posting behavior, thereby counteracting the effect of embeddedness. Furthermore, it might be that members adjust their posting behavior not by sending messages of a 'higher' quality, but by sending other types of messages that are more useful to their colleagues. An example could be that teachers are more willing to engage in interactive discussions about teaching problems. In this case, a higher embeddedness would thus lead to a stronger improvement of the teaching skills, although not necessarily to a 'higher' quality of the discussion contributions. What changes may not be the quality of the members' contributions, but the contributions fit better with other members' needs.

The study has a number of limitations. First, there are no hard indicators of the improvement of professional knowledge, teaching skills, and reception of information. The analyses rely on survey data and self-assessments of the teachers which may be prone to a self-serving perception bias. On the other hand, such a general bias could not explain that members in communities with a high embeddedness perceive more benefits. Moreover, the study controls for tendencies to provide socially desirable answers. Nevertheless, future research could use less subjective indicators of improvements of skills and knowledge. For instance, longitudinal studies could use the same indicators to test for changes and improvements over time. Also, tests that require knowledge about educational developments on a teacher's school subject could be used. Second, while the results suggest that there is an overall improvement of members' teaching skills, the results leave open in what sense they have improved. Teaching skills are treated as a black box. Future studies should open the black box and find out what specific didactic competencies teachers improved. For instance, teachers may become more self-assured towards difficult pupils because the online community provides access to kindred souls who experience similar problems. Alternatively, it may be that teachers increase specific didactic competencies, such as motivating pupils to learn self-learning, developing examination skills, etc. While this study provides evidence for some overall benefits, future studies could find out what specific competencies can be better improved via online communities for teachers' professional development and which competencies better should be improved via other paths.

The results, should they be reproduced in future studies, have a number of important implications for the design and management of online communities for teachers' professional development as well as for educational policy makers who aim at scaling up the use of online learning communities for teachers' professional development (Liebermann & Pointer Mace, 2010). First of all, from the

descriptive findings we can conclude that it pays for teachers to use online communities. The 'average' teacher gets at least some benefits. The benefits include improvements with respect to teaching skills, some updating of substantive knowledge about the school subject, and information about vacancies. The online communities did come with some costs because community administrators had to devote some of their working time to community management. Nevertheless these costs pay for themselves if we take into account the large number of teachers who are community members and profit from it. The average community consists of 740 members, the largest one has 3,682 members. Second, there is room for improvement. Still about a third of the teachers is unsatisfied with the quality of the knowledge exchange. Almost every second teacher is skeptical about an improvement of the subject knowledge. Some communities function better than other. Third, embedded communities deliver more benefits than purely virtual communities. This insight leads to a number of recommendations for community management. First, community administrators could create opportunities for offline meetings among members. In the teachers' communities of the Dutch virtual organization only about 7% of the members attended any meeting. Nevertheless their network of informal offline relationships was dense enough to show some beneficial effects. (Of course, some informal relationships may have emerged independently of the membership meetings.) Administrators of other communities could pursue such a strategy as well. Moreover, it may be wise for administrators to announce face-to-face meetings mainly to make the members regularly aware of the fact that some members know each other offline. Such efforts increase the *perceived* degree of embeddedness among members which is likely to have some beneficial effects as well. Furthermore, community administrators should carefully 'recruit' members. Recruitment of clusters of members who know each other already increases the embeddedness and is likely to create additional benefits. A careful and professional planning and execution of such activities is likely to incur some costs because it consumes working time. Alternative programs of a professional development of teachers, however, are not less costly. Given

the large return of educational investments, the moderate costs of setting up and actively managing online communities for teachers' professional development are likely to pay dividends in the future.

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Appendix

Appendix 1: Arithmetic means, standard deviations, and correlations

Variables	Mean	SD	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)	13
1) Satisfaction with quantity of exchange	3.4	1.1	1												
2) Satisfaction with quality of exchange	3.7	1.1	.42**	1											
3) Improvement of teaching skills	3.5	1.4	.26**	.47**	1										
4) Improvement of school subject knowledge	3.4	1.2	.28**	.44**	.64**	1									
5) Information about vacancies	3.1	1.3	.23**	.40**	.51**	.71**	1								
6)Membership length (7 categories)	2.41	1.34	-.01	.13**	.14**	.18**	.13**	1							
7) Digital literacy	-.01	.99	-.01	.07	.11**	.04	.05*	.17**	1						
8) Digital experience	6.48	1.86	-.01	.03	.01	-.05	.12**	.22**	.42**	1					
9) Frequency of OLC use (square-root)	4.27	4.06	.05	.14**	.26**	.26**	.24**	.13**	.07**	-.04	1				
10) Intensity of active use of the OLC	1.38	1.32	.01	.17**	.33**	.26**	.23**	.20**	.13**	.07**	.35**	1			
11) Social desirability	.59	.92	.02	-.03	.04	.03	-.01	-.01	-.01	.03	.01	-.03	1		
12) Gender (female=1)	.56	.50	-.01	-.01	.05	.12**	.00	-.08**	-.08**	-.14**	.14**	.02	.01	1	
13) Age ($\log_e$)	3.75	0.26	.01	-.09*	-.05	.04	.02	.15**	-.18**	-.14**	.0001	-.03	.09**	-.17**	1
14) Extent of full-time job as teacher ($\log_e$[%])	4.33	.34	.02	.05	-.01	-.02	.01	.10**	.02	.09**	.02	.03	.01	-.29**	.15**
Group variables (N=26)			Group size	Embeddedness											
Group size (raw data)	740	797	1												
Embeddedness	26.4	4.5	.46*	1											

n=1492 (n=725 for variables 1-2), N=26, * p < .05; ** p < .01; *** p < .001 (two-sided)

Appendix 2: Additional multilevel analyses including individual participation in face-to-face meetings as main effect and as interaction effect with embeddedness

Note: These analyses test whether a) the effect of embeddedness is a group-level or an individual-level effect and b) whether the effect of embeddedness differs between those who have face-to-face contacts (=participated at face-to-face meetings) versus those who have not. I restrict the analyses to tests of the first three hypotheses for which an effect of embeddedness was found.

Table Appendix 2: Embeddedness, face-to-face meetings, and cross-level interaction effect: Results of 2-level multiple linear regression analyses[+]

Variable	Teaching benefits	School subject benefits	Information on vacancies
	Estimated value (standard error)	Estimated value (standard error)	Estimated value (standard error)
Group level effect:			
Embeddedness	.051* (.025)	.072** (.027)	.067** (.026)
individual level effects:			
Participation in face-to-face meetings	.145 (1.91)	.730 (1.620)	1.830 (1.800)
Cross-level interaction:			
Participation X embeddedness	-.002 (.095)	-.032 (.080)	-.083 (.089)
*: p<=0.05	τ_0^2=0.03	τ_0^2=0.06	τ_0^2=0.04
**: p<=.01 (one-sided)	σ^2=1.61	σ^2=1.16	σ^2=1.43
n=1492 N=26			

n: level 1 sample size (number of individuals); *N*: level 2 sample size (number of communities);

τ_0^2 : level 2 variance of the intercept; σ^2: level 1 error variance

+: All three regression models include all control variables of Model 2 in Table 8. However, here just the effects of embeddedness, participation in face-to-face meetings, and the cross-level interaction variable (participation X embeddedness) are shown.

All three regression analyses lead to the same pattern of effects. The main effect of embeddedness is positive and significant whereas the other two effects are not significant. The results indicate that the effect of embeddedness is an effect of a characteristic of the whole community, and not of a single member. Members who have face-to-face contacts (=participated at face-to-face meetings) do not profit more than those who do not have face-to-face contacts. Moreover, the effect of embeddedness does not differ for those who participated at face-to-face meetings versus those who did not.

Tables

Table 1: Other control variables

Digital literacy: Slightly adapted version of Hargittai's (2005) scale: "How familiar are you with the following internet phenomena?", downloads, advanced searching, preference settings, newsgroups, pdf documents, refresh/reload, mp3 files, blogs, emailing lists, spam filters, all answers on 5 point Likert scales resulting in one factor score (alpha=.91, KMO value=.92). A logarithmic transformation of the score is used [x'=$\log_e$(x+3)] to reduce residual heteroscedasticity in the data.
Socially desirable answering tendency: Shortened version of BIDR 6 scaling procedure (Paulhus, 1991): answers on 7 point Likert scales to the following items: "My first impressions of people usually turn out to be right. It would be hard for me to break any of my bad habits (reversed). I always know why I like things. I sometimes tell lies if I have to. When I hear people talking privately I avoid listening. I don't gossip about other people's business."
Digital experience: years of internet use ranging from 0 to 8 (8=8 or more years)
Group size: Information from managers or website. A logarithmic transformation of the score is used.
Trusting disposition: Three items adapted from Jarvenpaa, Knoll, and Leidner's (1998) scale: "Most people are honest in describing their experiences and abilities. Most people answer personal questions honestly. Most people can be counted on to do what they say they will do." Answers lead to one factor score (alpha=.83, KMO value=.70).
Membership length: 5 categories: less than 5 months, 2-6 months, 7-12 months, 1-2 years, > 2 years
Frequency of OLC use: usage days of teachers' community (average days per week during last 4 weeks) X minutes of use per usage day. The square root of the resulting score is used.
Active use of OLC: 7-point Likert scale, answers ranging from *completely inactive* to *very active.* A logarithmic transformation of the score is used.
Age ($\log_e$), *gender*, and *extent of having a full-time job as teacher* ($\log_e$[percentage]) are also included.

Table 2: Individual satisfaction with general quality, general quantity, amount of teaching benefits, amount of school subject benefits, and information about vacancies

	GENERAL QUANTITY	GENERAL QUALITY	TEACHING BENEFITS	SUBJECT BENEFITS	VACANCIES
Mean	3.4	3.7	3.5	3.4	3.1
Median	4	4	3.5	3.5	3
Std. Deviation	1.1	1.1	1.4	1.2	1.3
Minimum	1	1	1	1	1
Maximum	7	7	7	6	6
N	725	725	1492	1492	1492

Table 3: Analysis of Variance of the five original indicators of satisfaction

		σ^2 *(SE)*	τ_0^2 *(SE)*	Intra-class correlation
Quantity	(n=725)	1.10 (0.06)	0.11 (0.04)	0.09
Quality	(n=725)	1.15 (0.06)	0.08 (0.04)	0.07
Teaching	(n=1492)	1.86 (0.07)	0.08 (0.03)	0.04
Subject	(n=1492)	1.31 (0.05)	0.14 (0.05)	0.10
Vacancies	(n=1492)	1.58 (0.06)	0.09 (0.04)	0.05
N=26				

n: level 1 sample size (number of individuals); N: level 2 sample size (number of communities); τ_0^2 : level 2 variance of the intercept; σ^2: level 1 error variance

Table 4: Two-level linear regression analysis of improvement of teaching skills

Variable	Model 1 Estimated value (standard error)		Model 2 Estimated value (standard error)	
Group level effect:				
Social embeddedness	.060*	(.028)	.051*	(.025)
Community size	.128	(.077)	.072	(.068)
Individual level effects:				
Digital literacy	.473**	(.087)	.323**	(.084)
Digital experience	-.031	(.021)	-.049**	(.020)
Social desirability	.068*	(.038)	.068*	(.036)
Gender (1=female)	.096	(.078)	.051	(.074)
Age	-.198	(.141)	-.257*	(.136)
Extent of full-time job as teacher	.038	(.110)	-.035	(.103)
Trusting disposition			.134**	.037
Membership length			.071**	(.027)
Frequency of community use			.002**	(.0005)
Active use of community			.678**	(.063)
*: $p<=.05$ **: $p<=.01$ (one sided)	σ^2= 1.81		σ^2=1.61	
N=1492 n=26	τ_0^2 = 0.05		τ_0^2 = 0.03	

N: Level 1 sample size (number of individuals); n: Level 2 sample size (number of groups);
τ_0^2 : Level 2 variance of the intercept, σ^2: Level 1 variance

Table 5: Two-level linear regression analysis of improvement of subject knowledge

Variable	Model 1 Estimated value	(standard error)	Model 2 Estimated value	(standard error)
Group level effect:				
Social embeddedness	.078**	(.031)	.071**	(.028)
Community size	.062	(.086)	.015	(.076)
Individual level effects:				
Digital literacy	.292**	(.073)	.165*	(.071)
Digital experience	-.031*	(.017)	-.050**	(.017)
Social desirability	.043	(.032)	.041	(.031)
Gender (1=female)	.308**	(.067)	.276**	(.064)
Age	.258*	(.119)	.167	(.116)
Extent of full-time job as teacher	.087	.092	.024	(.088)
Trusting disposition			.126**	.031
Membership length			.092**	(.023)
Frequency of community use			.002**	(.0004)
Active use of community			.478**	(.054)
*: p<=.05 **: p<=.01 (one sided)	σ^2= 1.28		σ^2=1.16	
N=1492 n=26	τ_0^2 = 0.09		τ_0^2 = 0.06	

N: Level 1 sample size (number of individuals); n: Level 2 sample size (number of groups);
τ_0^2 : Level 2 variance of the intercept, σ^2: Level 1 variance

Table 6: Two-level linear regression analysis of reception of information about vacancies

Variable	Model 1 Estimated value (standard error)		Model 2 Estimated value (standard error)	
Group level effect:				
Social embeddedness	.068*	(.027)	.064**	(.025)
Community size	.097	(.076)	.058	(.068)
Individual level effects:				
Digital literacy	.289**	(.080)	.179*	(.079)
Digital experience	-.002	(.019)	-.013	(.019)
Social desirability	-.008	(.035)	-.012	(.035)
Gender (1=female)	.342**	(.073)	.303**	(.070)
Age	.224*	(.130)	.175	(.129)
Extent of full-time job as teacher	.184*	.101	.131	(.098)
Trusting disposition			.145**	.035
Membership length			.049*	(.026)
Frequency of community use			.002**	(.0005)
Active use of community			.435**	(.060)
*: p<=.05 **: p<=.01 (one sided)	σ^2= 1.54		σ^2=1.44	
N=1492 n=26	τ_0^2 = 0.05		τ_0^2 = 0.04	

N: Level 1 sample size (number of individuals); n: Level 2 sample size (number of groups);
τ_0^2 : Level 2 variance of the intercept, σ^2: Level 1 variance

Table 7: Two-level logistic regression analysis of satisfaction with quantity of material

Variable	**Model 1** Estimated value (standard error)		**Model 2** Estimated value (standard error)	
Group level effect:				
Social embeddedness	.049	(.061)	.058	(.062)
Community size	.205	(.165)	.208	(.166)
Individual level effects:				
Digital literacy	-.100	(.183)	-.061	(.187)
Digital experience	.050	(.046)	.077	(.048)
Social desirability	.152*	(.090)	.136	(.091)
Gender (1=female)	.200	(.170)	.175	(.175)
Age	.086	(.309)	.191	(.319)
Extent of full-time job as teacher	.028	.238	.092	(.241)
Trusting disposition			.128	(.083)
Membership length			-.143*	(.067)
Frequency of community use			.003*	(.0015)
Active use of community			-.138	(.149)
*: p<=.05 **: p<=.01 (one sided)				
N=725 n=26	$\tau_0^2 = 0.22$		$\tau_0^2 = 0.22$	

N: Level 1 sample size (number of individuals); n: Level 2 sample size (number of groups);
τ_0^2 : Level 2 variance of the intercept

Table 8: Two-level linear regression analysis of satisfaction with quality of material

Variable	Model 1 Estimated value (standard error)		Model 2 Estimated value (standard error)	
Group level effect:				
Social embeddedness	.030	(.032)	.018	(.031)
Community size	.096	(.088)	.078	(.088)
Individual level effects:				
Digital literacy	.167*	(.093)	.086	(.093)
Digital experience	.000	(.023)	-.011	(.023)
Social desirability	-.026	(.045)	-.027	(.045)
Gender (1=female)	-.003	(.089)	-.019	(.089)
Age	-.331*	(.159)	-.378**	(.159)
Extent of full-time job as teacher	.189	.122	.169	(.121)
Trusting disposition			.123**	.041
Membership length			.059*	(.033)
Frequency of community use			.001*	(.0006)
Active use of community			.193**	(.074)
*: p<=.05 **: p<=.01 (one sided)	σ^2= 1.13		σ^2=1.08	
N=725 n=26	τ_0^2 = 0.07		τ_0^2 = 0.07	

N: Level 1 sample size (number of individuals); n: Level 2 sample size (number of groups);
τ_0^2 : Level 2 variance of the intercept, σ^2: Level 1 variance