

Social Network Service with Maturity Level for Science Teachers

Masayuki Sakoda, Yoshihisa Wada, Hiroshi Tsuji and Kazuhisa Seta

Osaka Prefecture University
Osaka, Japan

{sakoda@mis.cs, wada@mis.cs, tsuji@cs, seta@mi.s}.osakafu-u.ac.jp

Abstract—To support Japanese teachers with sharing their knowledge on digital contents usage, this paper proposes a social networking service. While the digital contents prepared by *Japan Science and Technology Agency* are attractive for innovating education, most teachers spend much time to prepare their classes. We have found a necessity to define a maturity level for teachers on sharing knowledge. This paper proposes not only a user interface with a recommended message by maturity level but also an expanded data model for implementation. This proposal is expected to save time for preparing ICT-based classes and to improve classes by sharing knowledge.

Keywords— Knowledge Management, Maturity Model, Social Networking Service, User Interface, Digital contents

I. INTRODUCTION

In recent years, personal computers and high-speed Internet services have become available and are commonly used at primary, middle and high schools. The ICT (Information and Communication Technology) lessons based on digital contents are carried out in various places. This trend has become common in Japan and some reports show statistics how such lessons are effective for raising the academic ability of students [1] [2]. Therefore, it is expected that the activity for such ICT lessons continue to prosper.

This is especially true in science lessons as they not only involve dangerous instruments like radiation but also request 3D visualization like spherical movement and cell fission. It becomes possible by introducing digital contents to explain such topics for students efficiently and effectively.

According to such background, Japan Science and Technology Agency (JST) has offered the digital contents for science education for a couple of years at the Internet site called "RikaNetwork" (<http://www.rikanet.jst.go.jp/>). It is said that most Japanese science teachers have already downloaded contents from the site and have created their original guidance plans with the digital contents.

However, the knowledge and experience (including guidance plans, success/ failure practices, and original ideas) have still stagnated unfortunately in an individual area in many cases. In other words, even if a teacher wants to use another teachers' guidance plan, there are no chances to do it. Therefore, if it becomes possible to share the knowledge which each

teacher holds, we think that the value of digital contents greatly increases higher for improving science education.

According to our analysis and field study, there are several varieties of capability level for using digital contents. While some teachers are very eager to use them and to share their good practices, others hesitate not only to open their experience but also to spend time preparing for their digitized classes.

Therefore, in order to promote digitized classes and to improve the quality of science classes, this paper proposes a SNS (Social Networking Service) with maturity level. The special feature of this research is not only to show the user interface with a recommend message by maturity level but to design an expanded data model for implementation as well.

II. ANALYSIS OF PRESENT STATE

A. RikaNetwork

"RikaNetwork" is an Internet site which provides schools with the advanced digital teaching materials concerning science education which JST developed. There are attractive digital materials exceeding about 40,000 points: digital movies, still pictures and animations. According to the agreement under the condition of nonprofit and educational purpose, any teacher is allowed to use, process, change, and share them.

As of September 25, 2008, more than 40,000 Japanese teachers had registered to use digital contents provided by "RikaNetwork". Note that "RikaNetwork" is not always everything for education. Amalgamating a digital content and actual experiment observation enables students to tackle a subject in visual and experience. Then, how to amalgamate them is a hot topic among science teachers.

B. Subject

In order to identify the problem of using digital contents efficiently and effectively, we obtained the opportunity to participate in an open lesson and research deliberations in the Osaka Prefecture. We also conducted interviews and questionnaire surveys on the teachers who participated in these research meetings [3].

Moreover, to grasp magnitude and significance of the problems, we accessed to the "RikaNetwork" and created a couple of guidance plans (an example is shown in Appendix). As a result, the following points were to be considered:

- The difference of maturity on digital contents usage

It was true that there were active teachers who innovate in lessons with their created guidance plans. They often modified the digital contents according to their teaching objectives for their classes.

On the other hand, it was also true that teachers who were not familiar with ICT spent their time creating guidance plans. While some novice teachers were active to learn new technology for innovating their class, others were hesitant to change their traditional work practices.

- Stagnation of knowledge

There is a requirement that each teacher would like to refer to the guidance plan created by others. However, the current "RikaNetwork" is a one way system for downloading digital contents created by JST. It does not have the bidirectional mechanism of indicating the guidance plans and digital contents. Thus, even if some have good practices or failed ones in their classes, there are no chances to share their knowledge among teachers without face-to-face meetings.

Today, such real meetings have been held once or twice a year in each region. However, the knowledge acquired from the training by region has been stagnant in the range of participants, and the valuable knowledge has faded out in many cases. In order to externalize good practices for others, there are printed materials published by local autonomous bodies [4]. However, they require time for publication and are not updated frequently. Therefore, even if a mistake and corrective strategy are found after publication, it is difficult to acquire the information in real time. Thus, it can be said that the knowledge about ICT lesson has still stagnated.

According to such considerations, the subjects we should tackle are as follows: (1) in order to lessen the difference

among teachers on their capability, we will define the maturity of the teacher regarding digital-contents usage, and (2) in order to offer structure which improves the mechanism of sharing knowledge, we design user interface and data model for building a knowledge-network among teachers.

III. MATURITY AND A KNOWLEDGE-NETWORK

A. The definition of maturity

By setting up maturity levels, it becomes possible to aim at the next higher level in digital-contents practical use after a teacher gets the present level. The basic idea is referred from CMM (Capability Maturity Model) used as a measure which evaluates the level of a software development organization [5] [6] [7].

Considering a teacher who exhibits successful experience widely as good practice and maintains it as an ideal image (see TABLE 1), this paper defines five levels for science teachers on maturity about digital-contents practical usage ability. The left column shows basic action of teachers, and the central column is consideration from the view of knowledge internalization. The right column is that from the view of knowledge externalization.

- Maturity 1

This level for novice teachers on digital contents assumes the state in trial usage. The teachers in this level start to download digital contents in trial from "RikaNetwork" but do not create their own guidance plans yet. In this level, knowledge has stagnated within the individual range. Therefore, the target of the following maturity 2 is shown for them so that the guidance plans which other teachers created may be perused and an improved guidance plans actually may be created.

- Maturity 2

TABLE I. THE MATURITY MODEL DRAFT ON TEACHERS

| Teacher (user) | | | |
|----------------|--|--|--|
| Level | Basic Action | Internalization from * | Externalization to * |
| 5 | Continuous knowledge sharing for good practice | Consult personal guidance plans provided by teachers | Evaluate guidance plans and contents which other teachers created Improve and change provided guidance plans Open original guidance plans globally |
| 4 | Knowledge sharing for building good practice | | |
| 3 | Knowledge sharing among local community | | |
| 2 | Learn from self-experience and others | | |
| 1 | Trial use (It takes great time) | | |
| | | Download digital contents provided by JST | Create guidance plans for personal use |

This level assumes that teachers have ability not only to learn from success/failure of self-experiences and others but also to externalize their experiences for the future. A teacher in this level creates his original guidance plans with reference to the guidance plan produced by others.

According to authors' view, many teachers have stayed at this maturity level 2. The target of the following maturity level 3 is shown so that the guidance plan made on one's own should be opened to a local community (acquaintance) and improved step by step by getting review.

- Maturity 3

This level assumes the stage that knowledge is shared not globally but locally. The precise definition on "locally" is not important. For example, we suppose that a teacher like to share his guidance plan within a specific range called an acquaintance. He does not want his work to be referred to strangers. Even if the knowledge sharing is limited in local community, it is possible to verify the advantage of the original guidance plan and to improve faults through review.

The target of the following maturity 4 is shown so that an original guidance plan is not limited to share with teacher in any specific community. If any teacher in Japan can comment on the guidance plan which other teachers created, there is a great chance to find the availability of the original digital contents.

- Maturity 4

This level assumes the teacher has an ability to adopt good practices. It is true that no teacher can create good practice by oneself. His students may give feedback to his idea. His colleague may point out some defects. To get feedback for getting good practice, a teacher in this level should share the original guidance plan with all teachers in Japan and comment on other teachers' guidance plan for improvement. He should also exhibit his original contents by improving and changing digital contents. The target of the following maturity 5 is shown so that he continues to perform this action.

- Maturity 5

This level assumes the teacher who has ability for change management on good practice. Even if the good practice is defined once, it cannot always be good for ever. According to the change of environment including government policy and students' motivation, the good practice may be modified. For the teacher at this level, the message for maintaining this level is appropriate.

Defining maturity levels as mentioned above enables teachers to understand the current state and their upper target. Being shown corresponding targets, each teacher receives stimulus so that he could bi-directionally share knowledge with other teachers (knowledge internalization and externalization). Thereby, each teacher can see whether digital contents can be used effectively and whether knowledge is bi-directionally shared. Therefore, it is expected that introduction of maturity levels leads to not only bringing a teacher the effect of plus but also raising value of "RikaNetwork" among teachers.

B. Knowledge network

This section insists that the original "RikaNetwork" cannot be a platform for knowledge sharing based on maturity level. While "RikaNetwork" is a knowledge repository, the knowledge sharing among teachers requires a knowledge-network [8].

The contents providers for "RikaNetwork" are limited to experts. Most teachers are just users and cannot be knowledge providers or contents providers. On the other hand, at the knowledge network, every teacher should provide their original guidance plan and give feedback as lesson learnt. The knowledge network should be based on relationships among teachers.

Let us validate our standpoint. It is reported that the majority of knowledge is not generated by individual internal activity but by communication as a social process [9]. On the digital space for the social process, SNS is recent idea. Our proposal is to implement maturity levels in SNS for showing teachers upper target.

Then let us review SNS in the context of our proposal. One of most famous SNS, called *mixi* [10], has 16 million users. Users continue to invite their friends to *mixi*, and their friends repeat the same invitation. The company and local government have an interest in such SNS for knowledge infrastructure of their organization [11]. Every user in SNS can be knowledge providers as well as knowledge users. Therefore, SNS is a good platform for knowledge sharing among science teachers.

The basic question on SNS is why a user will continue to use SNS and how to keep incentives for using SNS. While a special function based on "Stickiness" for inviting users are also discussed elsewhere [12], our proposal is introduction of maturity levels.

The traditional SNS has several functions including diary, community, review and invitation. Such functions are equipped with authentication level. A science teacher can disclose his externalized knowledge via diary and gives feedback via review. Viewing volumes of guidance plans and their feedback, he has the chance to internalize knowledge learnt in classrooms. The invitation function allows him to maintain relationships among teachers. He traverses the knowledge network from his colleague to colleague's acquaintance.

Again, knowledge network in SNS expresses chain of teachers. It stimulates teacher to share knowledge. At the initial stage, it is reasonable that knowledge is shared among local community. Changing the authentication level, the knowledge can be shared among teachers globally.

Let us review SECI model [13] in the context of our proposal. As *Socialization*, teacher gives his lesson in a classroom. Through the lesson where he acquires tacit knowledge, as *Externalization* he writes diary with guidance plan. Then other has chance to share knowledge. As *Combination*, each lesson learnt is stored in a database of SNS. To learn the knowledge by reading disclosed knowledge in database is exact *Internalization*.

To repeat socialization, externalization, combination and internalization allows knowledge spiral where one's action

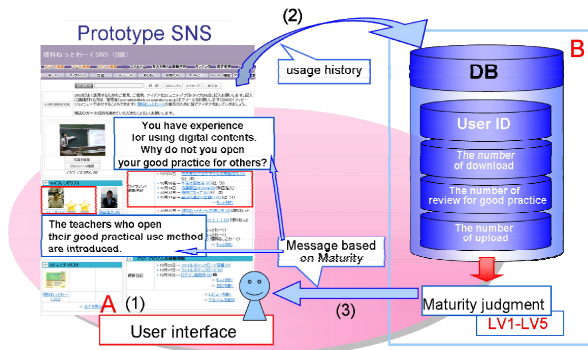


Figure 1. System overview

induces other's action repeatedly. We can regard this knowledge spiral as mass-collaboration discussed in [14].

IV. THE PROPOSAL OF A KNOWLEDGE MANAGEMENT SYSTEM

A. System outline

The proposed system consists of user interface and DB as shown in Figure 1. Through user interface A, a teacher exhibits his own guidance plan, and performs download and review of other teachers' guidance plan. Each teacher's access log is stored in Database B for deciding his maturity level. According to the defined maturity level, this system presents the upper target which should be aimed at next for a teacher and supports to raise teacher's maturity. As example of a concrete message, the proposed system sends the message which promotes to exhibit the guidance plan for teachers who does not exhibit it. In other case, the system introduces the teachers who exhibit the practical and beneficial use method concerning digital contents.

Thus, considering the knowledge management system with maturity levels supports each teacher in his stage, and it leads to construction of the knowledge network based on human relationship. The prototype system was created using "OpenPNE", one of the open source used in many SNS systems in Japan. Figure 2 shows a screen example of prototype "RikaNetwork SNS (<http://esteem.center.osakafu-u.ac.jp/>)"

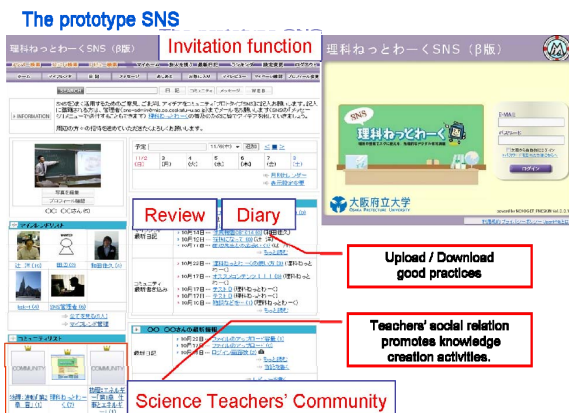


Figure 2. SNS for Science Teachers

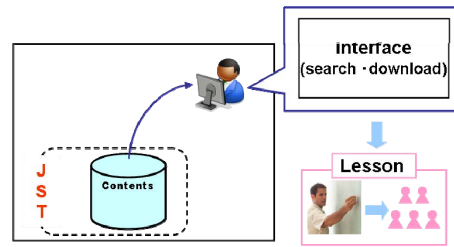


Figure 3. User Interface for Level 1 Teachers

rikonet-sns/) currently operating on the Internet in trial.

The environment used in developing a proposal system is as follows:

- Windows Server 2003 Service Pack 2,
- XAMPP Windows/1.6.7,
- Apache/2.2.9,
- MySQL Server/5.0.67,
- MySQL Client/5.0.51b,
- phpMyAdmin/2.11.9.1.

B. User interface

Let us introduce the designed user interface. As shown in Figure 3- Figure 7, the prototype systems generates different advising messages by maturity levels while any teacher can use the whole function of SNS. In other words, the system prepared a set of message for teachers in level i to encourage being level $i+1$ teachers.

(1) For maturity level 1 in Figure 3

A teacher at this level only downloads digital contents from database. Then the message encourages him to read guidance plan provided by others and to externalize his lesson learnt.

(2) For maturity level 2 in Figure 4

A teacher at this level has seen the guidance plan provided by others and created his guidance. Then he receives message which encourages opening his own guidance plan for others.

(3) For maturity level 3 in Figure 5

A teacher at this level shares lesson learnt among local community. He will be encouraged by message to open his knowledge globally. He will also be asked to review guidance plans and original digital contents provided by others. The review includes evaluation indicated by the number of star.

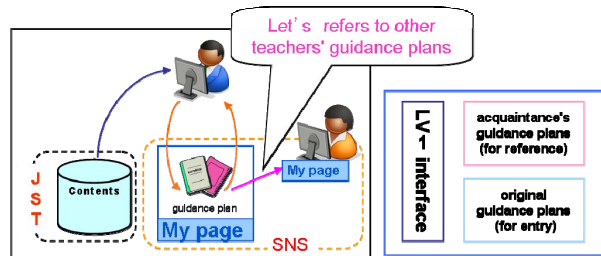


Figure 4. User Interface for Level 2 Teachers

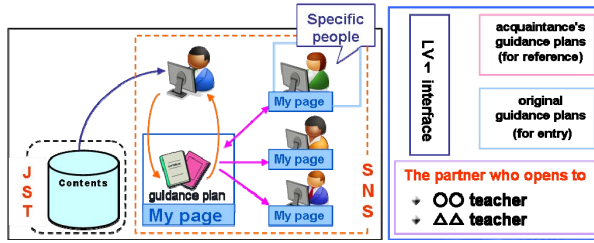


Figure 5. User Interface for Level 3 Teachers

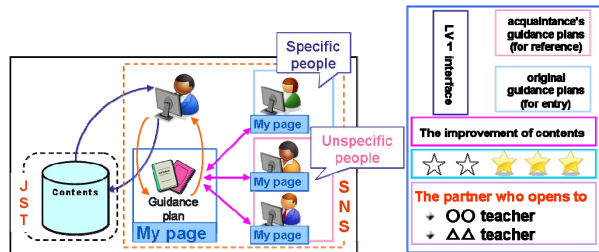


Figure 6. User Interface for Level 4 Teachers

(4) For maturity level 4 in Figure 6

A teacher at this level starts to share knowledge among teachers globally. He is also encouraged to invite his colleague to SNS.

(5) For maturity level 5 in Figure 7

At this level, the teacher is required to continue knowledge sharing. Especially, because the environment may change, they should exclude out-of-date knowledge and keep knowledge available.

C. Outline of DB

Both the original SNS "OpenPNE" and the knowledge repository "RikaNetwork" have their own data model. The new relation should be added to them. The overview of ER model is shown in Figure 8. The extension includes six kinds of tables:

- (1) Guidance Plan Table,
- (2) Guidance Plan Counting Table,
- (3) Guidance Plan Comment Table,
- (4) Digital Contents Upload Counting Table,

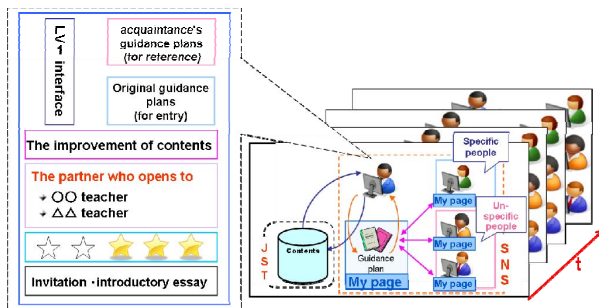


Figure 7. User Interface for Level 5 Teachers

TABLE II. The maturity model draft on Teachers in RikaNetwork

| Level | Registration with RikaNetwork | Download of digital contents $DN_i=1$ |
|-------|-------------------------------|--|
| 1 | Registration | Download $\geq DN_i/\text{year}$ |

TABLE III. The maturity model draft on Teachers in RikaNetwork SNS

| Level | Use | | Offer | |
|-------|--|--|--|---|
| | The number of download of others' guidance plan $VN_i=5, VN_i=20$ $VN_i=50, VN_i=10$ | The open number of one's guidance plan $ON_i=1$ | The number of improve and change contents and upload $UN_i=1$ | The number of Comment (evaluation) to a guidance plan $CN_i=5$ |
| 5 | $\geq VN_i/\text{year}$ | $\geq ON_i/\text{year}$ | $\geq UN_i/\text{year}$ | $\geq CN_i/\text{year}$ |
| 4 | $\geq VN_3$ | open to unspecified teachers $\geq ON_1$ | $\geq UN_1$ | evaluation $\geq CN_1$ |
| 3 | $\geq VN_2$ | open only to friend teachers | - | - |
| 2 | $\geq VN_1$ | no open | - | - |
| 1 | - | - | - | - |

(5) Digital Contents Download Counting Table,

(6) The relation between Digital Contents and Guidance Plan table.

D. Judgment of maturity

Preparing six kinds of tables introduced in the previous section, the judgment of maturity level can be defined computationally. The drafts of maturity model concerning teachers are shown in Table 2 and Table 3.

V. CONCLUSION

This paper has proposed a social networking service with maturity level for Japanese science teachers. The main goal is to support them for sharing their knowledge on digital contents usage. To achieve the goal, this paper has extracted the necessity of maturity level for a knowledge network.

This paper has defined the maturity levels for science teachers concerning digital contents practical use by five steps, and has clarified the structure of DB which is needed for user interface and maturity judging. The proposed system has offered the method of promoting knowledge sharing according to teacher's maturity levels. Therefore, it enables each teacher to get to know the present mature condition, and it makes possible to show the upper target which should be aimed at next.

Thereby, it is expected that knowledge about the digital contents which neither an individual nor an individual organization can get will be expanded through a knowledge network and will be refined by mass collaboration. Moreover, it is also expected that considering maturity is effective to achieve critical mass (the number of users which can guarantee the stable use).

ACKNOWLEDGMENT

This work is partially supported by Japan Science and Technology (JST). Some ideas come from discussion with Osaka Prefectural Education Center who gave opportunities to observe and review experimental classes in elementary or junior high schools. The authors would like to be grateful to Mr.

Kenji Kaibe and Mr. Hisanobu Tanabe for giving valuable chances and comments.

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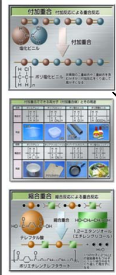
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APPENDIX. SAMPLE GUIDANCE PLAN

| osynthetic polymer < http://www.rikanet.jst.go.jp/contents/cp0240/start.html > | | | | |
|--|---------------|---|--|---|
| 学習過程 | 内容 | 指導 | コンテンツ | LINK |
| 導入 6分 | 合成高分子とは | 合成高分子の制 | | |
| 展開 35分 | 重合の形式 付加重合 | 合成高分子は、単量体(モノマー)を多数重合させて得られる重合体(ポリマー)である ・付加重合の説明 ・ポリ塩化ビニル |  | Movie http://www.rikanet.jst.go.jp/contents/cp0240/c02/c02_1/c02_1_index.html |
| | 縮合重合 | ・縮合重合の説明 ・テレフタル酸+エチレンジグリコール ⇒ポリエチレンテレフタレート ・アジピン酸+ヘキサメチレンジアミン ⇒6,6-ナイロン |  | http://www.rikanet.jst.go.jp/contents/cp0240/c02/c02_4/c02_4_a/c02_4_a_index.html |
| | 特殊な重合 開環重合 | ・開環重合の説明 ・ε-カプロラクタム ⇒ε-カプロン |  | http://www.rikanet.jst.go.jp/contents/cp0240/c02/c02_5/c02_5_index.html |
| まとめ 5分 | | 高分子化合物とその用途 ・モノマーとポリマー ・付加重合 ・付加重合体とその用途 ・縮合重合 ・縮合重合体とその用途 ・開環重合 |  | URL Screen sample |

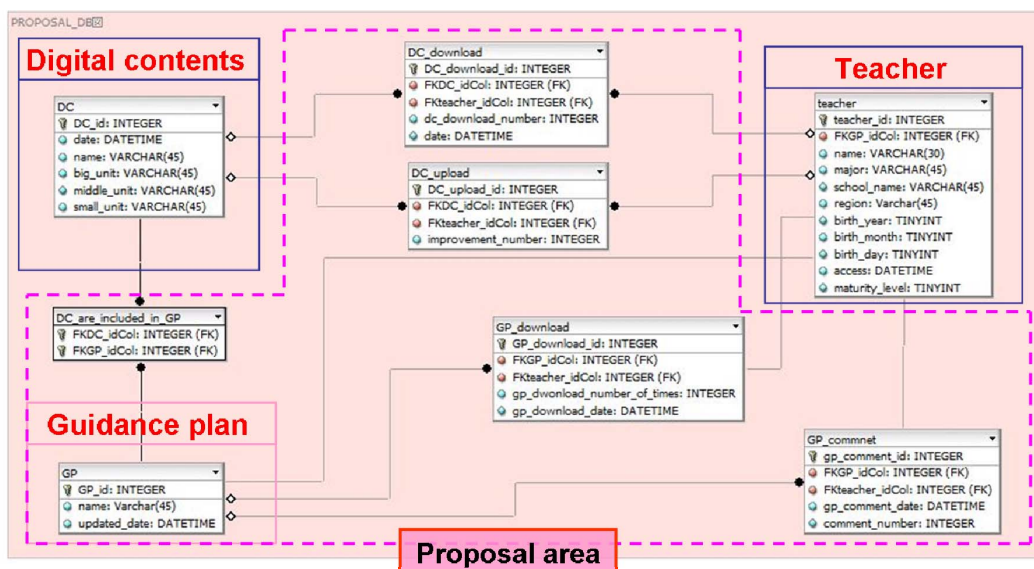


Figure 8. Database overview