The Development and Evaluation of the Online Science Fair Inquiry System

Chi-Hsuan MAI[a], I-Hua CHUNG[a], Zong-Rong YANG[b], Li-Jen WANG[a] & Ying-Tien WU[a]*

[a]*Graduate Institute of Network Learning Technology, National Central University, Taiwan*
[b]*Graduate Institute of Science Education, National Changhua University of Education, Taiwan*
*ytwu@cl.ncu.edu.tw

Abstract: Science fair is one of the most common open inquiry activities which can facilitate learners to construct their science knowledge and develop science literacy in school. However, there are a great deal of difficulties and challenges in Taiwan's education fair. For example, novice teachers may neither effectively guide learners to conduct science fair inquiry activities nor facilitate learners to construct related knowledge. To scaffold teachers' instruction and students' learning in science fair inquiry, the "Online Science Fair Inquiry System" (OSFIS) was developed in this study. After the development of the OSFIS, this study also conducted a series of system evaluations on it. To this end, both questionnaire survey and tape-recorded interviews were conducted. The participants of the system evaluation in this study were 52 elementary school teachers. The participants expressed satisfactory perceived usefulness and ease of use of the OSFIS. Also, they had high intention to use the OSFIS. Moreover, this study reveals that the OSFIS may facilitate both teachers and students to understand the process of science fair inquiry, solve the limitation of activities times, record the portfolio during inquiry activities, and complement teachers' professional knowledge. Results also indicated that the participants' perception toward OSFIS might be influenced by environmental limitation, and their professional knowledge of science fair and confidence. Finally, some suggestions and implications for teachers to conduct open inquiry activities, system design, and future work are also proposed.

Keywords: Science fair, inquiry, online science fair inquiry system, technology-enhanced inquiry tool

Introduction

There is no doubt that inquiry is the core of modern science education. The major educational goal of Inquiry-based teaching or inquiry-based instruction is to help learners study science inquiry skills and enhance the understanding of science inquiry [1]. In general, there are five stages of an inquiry activity in science classroom; namely questioning, planning, implementing, concluding, and reporting [2]. According to the openness of inquiry activities, Bell et al. [3] categorized four different levels of inquiry activities: confirmation, structured inquiry, guided inquiry, and open inquiry. For science educators, K-12 students are expected to be able to conduct open inquiry. In practice, science fair is the most common open inquiry activity in science classrooms. In many countries, science fair is adopted help student learn science [4]. However, the literature revealed that many teachers may lack of professional knowledge, time, recourses, and assistance when conducting science fair instruction [5]. Only few science teachers know how to guide students to conduct science fair projects or inquiry activities effectively [6]. In particular, in recent years, lower and lower quality of the science fair projects

conducted by elementary school students has been found in Taiwan. Therefore, how to scaffold elementary school teachers' instruction and students' learning in conducting science fair projects is crucial for the authors. In recent years, various technology-enhanced inquiry tools has been developed to scaffold inquiry activities for science learners [7, 8], for example, SCI-WISE [9] and WISE (Web-based Inquiry Science Environment) [10]; were developed for scaffolding inquiry activities in science curriculum. Besides, Symphony or The Digital Ideakeeper [11] was developed for scaffolding online inquiry. However, technology-enhanced inquiry tool for scaffolding science fair inquiry is still not yet available. In order to scaffold elementary school science teachers' science fair instruction and students' learning in science fair inquiry, this study aimed to develop the "Online Science Fair Inquiry System" (OSFIS). After the development of the OSFIS, this study also conducted a series of system evaluations on it.

1. System development

1.1 Participants of system development

The OSFIS developed in this study aims to provide a platform for elementary teachers who are interested in personal professional development regarding science fair instruction. They can enhance their professional knowledge by using this platform to guide learners to conduct science fair inquiry activities or facilitate learners to construct related knowledge. The development of this system is coordinated by science education and e-learning researcher, in-service science teacher, and system designer. By combining researcher's professional knowledge and in-service teacher's practical experience with system designer's software skills the system design therefore can be more practical for teachers to use (Figure 1).

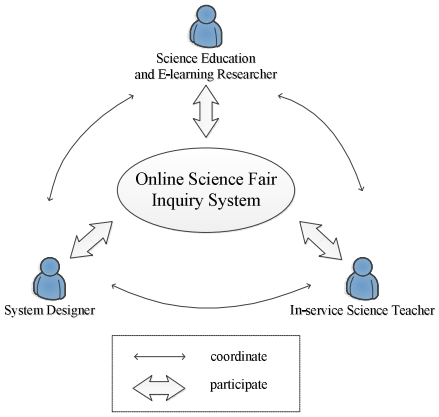

Figure 1. Participants of system development

1.2 System flow chart

The system flow chart of the OSFIS is depicted in the following diagram (Figure 2). As shown in Fig. 2, a solid line stands for student's behavior while a dotted line stands for teacher's behavior. This chart is composed of a series instruction module which guides learners in groups to finish five science fair inquiry stages, as suggested by Lee et al. [2]. Once the students finish each stage of science fair inquiry, they can submit their work to the work reviewing module. If teacher approves the work, then students can get the next science fair inquiry stage. If not, they need to revise their work according to their teacher's comments and resubmit their revised work. After students finish the five stages, they have completed a science fair project.

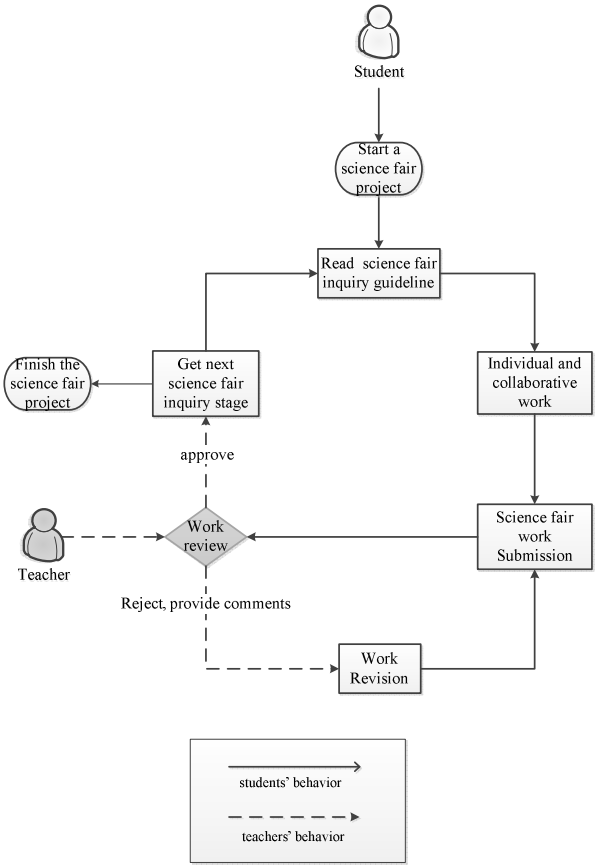

Figure 2. System flow chart

1.3 System framework

The system framework of the OSFIS is depicted in the following diagram (Figure 3). As shown in Fig. 3, the interaction between users and system modules is presented with a solid line while the interaction between system modules and databases is presented with a dotted line. This system framework consists of five main modules and four databases. The four databases store user information, inquiry process log, science fair knowledge, and science fair project management database. The five modules include user information, interaction and reflection, collaboration, science fair project, and teacher supervision module.

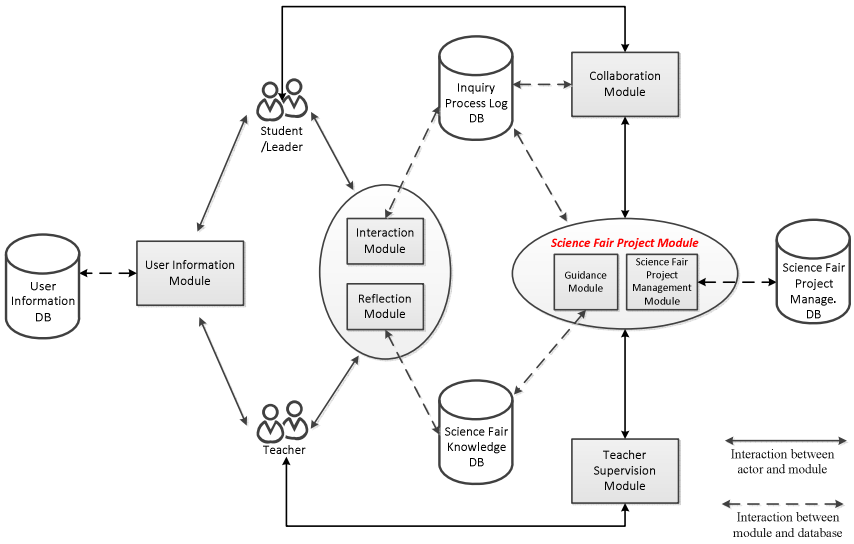

Figure 3. System framework

2. Methodology (System evaluation)

2.1 Participants

The participants of this study consisted of 52 elementary teachers (25 males and 27 females) whose teaching experience ranged from 3 to 27 years, with an average of 12.38 years. They all had the experience of instructing science fairs. 37 (71.15%) teachers had one to five years teaching experience. 13(25%) had six to ten years teaching experience. Only 2 (3.85%) teachers had more than ten years teaching experience. In general, most participant teachers in this study did not have enough science fair instructional experience which was perfect for this system evaluation.

2.2 Instruments

In this study, the participant teachers' perceived usefulness and usability of the OSFIS as well as their willingness of using the OSFIS were evaluated. To this end, the 6 Likert-scale questionnaire developed in Yuen & Ma was adapted and used in this study [12]. The modified instrument consists of three scales: usefulness (5 items), usability (5 items), and willing of use (4 items). All the alpha reliability values of the three scales are greater than 0.8, and the overall alpha reliability value of the instrument is 0.95 (Table 1). The participants also had in-depth (tape-recorded) interview about their views of system functions and the willingness of use right after exploring the system.

Table 1: Item numbers, reliability, and sample items of the instrument scales

Scale	Item	α	example item
ITU	5	0.96	I would like to use OSFIS to conduct science fair.
PU	5	0.91	I find using OSFIS can enhance my teaching.
PEOU	4	0.89	It is easy for me to master the operation of OSFIS.

ITU, Intention to Use; PU, Perceived Usefulness; PEOU, Perceived Ease of Use), Over all α = 0.95

2.3 Data collection

There were four stages of data collection. First, the authors gave directions of the study and collected the participant teachers' background information before the teachers explored the system. And then the participants start exploring the system by themselves. Third, after the exploration task, teachers evaluated usefulness, usability, and willingness of use of the system by using a questionnaire developed in this study. Finally, they had an in-depth interview in order to collect qualitative data (Fig 4).

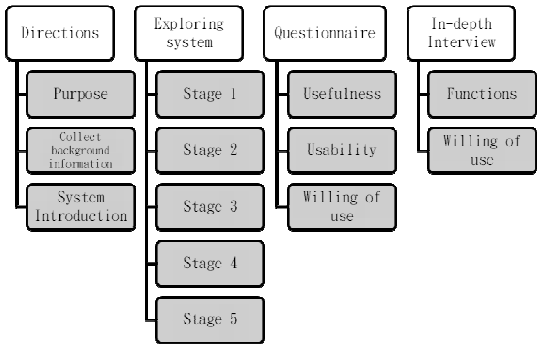

Figure 4. Data collection procedure

3. Major findings and Conclusions

3.1 Major findings

The collected data were analysed both quantitatively and qualitatively. Table 2 shows that the teachers' average scores on usefulness, usability, and willingness of use are between 4.98 to 5.05, which were higher than the 6 Likert scale average score (i.e., 3.5). It indicates that the participants in this study generally held positive attitude toward the system and were willing to use it.

Table 2. The overall results of system evaluation of the OSFIS

Scale	Mean	S.D.
Usefulness (5 items)	4.98	0.79
Usability (5 items)	4.92	0.64
Willingness of use (4 items)	5.05	0.92

Moreover, according to the results of in-depth interviews, most participants held positive attitude toward this system. They also expressed that this system can help them develop pedagogical content knowledge regarding science fair instruction and facilitate students to construct related knowledge.

> *"The system helps me give instruction to students when we are doing science fair. Students have very clear stages to follow."* (T26)
> *"Mission map is good for the students to use. The interface is interesting."* (T40)

However, some participants gave some valuable suggestions, such as the system design, interface design.

> *"The process of science fair preparation work is dynamic, it might need several revisions."* (T02)
> *"Teacher's instruction log should have the function of dates in order to trace back the instructing procedure."* (T31)

3.2 Conclusions

To scaffold teachers' instruction and students' learning in science fair inquiry, the "Online Science Fair Inquiry System" (OSFIS) was developed in this study. After the development of the OSFIS, this study also conducted a series of system evaluations on it. The participants expressed satisfactory perceived usefulness and ease of use of the OSFIS. Also, they had high intention to use the OSFIS. Moreover, this study reveals that the OSFIS may facilitate both teachers and students to understand the process of science fair inquiry, solve the limitation of activities times, record the portfolio during inquiry activities, and complement teachers' professional knowledge. However, from the in-depth interviews, some teachers also gave concrete suggestions of the system design which may be provided as the future revision of the system. Based on the findings in this study, the OSFIS can be improved in future work. Besides, to help teachers being familiar with the OSFIS, workshops or relating tutoring in advance are necessary for teachers.

Acknowledgement

This study was funded by the National Science Council, Taiwan, ROC, under grant contract number NSC 99-2511-S-008-007-MY3 and NSC 101-2628-S-008-001-MY3, but the opinions expressed in this article do not reflect the position of the National Science Council.

References

[1] National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: The National Academies Press.

[2] Lee, O., Buxton, C., Lewis, S., & LeRoy, K. (2006). Science inquiry and student diversity: Enhanced abilities and continuing difficulties after an instructional intervention. *Journal of Research in Science Teaching, 43*(7), 607-636.

[3] Bell, R. L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The science teacher, 72*(7), 30-33.

[4] Bencze, J. L., & Bowen, G. M., (2009). A national science fair: Exhibiting support for the knowledge economy. *International Journal of Science Education, 31*, 2459-2483.

[5] Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1-12.

[6] Justi, R., & Gilbert, J. K. (2002). Modeling, teachers' views on the nature of modeling, and implications for the education of modelers. *International Journal of Science Education, 24*(4), 369–387.

[7] Hill, J. R., & Hannafin, M. J. (2001). Teaching and learning in digital environments: The resurgence of resource-based learning. *Educational Technology Research and Development, 49*(3), 37-52.

[8] Kim, M. C., Hannafin, M. J., & Bryan, L. A. (2007). Technology-enhanced inquiry tools in science education: An emerging pedagogical framework for classroom practice. *Science Education, 91*(6), 1010-1030.

[9] White, B. Y., Shimoda, T. A., & Frederiksen, J. R. (1999). Enabling students to construct theories of collaborative inquiry and reflective learning: Computer support for metacognitive development. *International Journal of Artificial Intelligence in Education (IJAIED), 10*, 151-182.

[10] Linn, M. C., Clark, D., & Slotta, J. D. (2003). WISE design for knowledge integration. *Science Education, 87*(4), 517-538.

[11] Quintana, C., Reiser, B. J., Davis, E. A., Krajcik, J., Fretz, E., Duncan, R. G., & Soloway, E.(2004). A scaffolding design framework for software to support science inquiry. *The Journal of the Learning Sciences, 13*(3), 337-386.

[12] Yuen, A., & Ma, W. (2008). Exploring teacher acceptance of e-learning technology. *Asia-Pacific Journal of Teacher Education, 36*(3), 229–243.