

STUDENTS' PERSPECTIVE OF PRACTICAL WORK IN LEARNING SCIENCES VIA DISTANCE EDUCATION

Jason K.Y. Chan
The Open University of Hong Kong

Namin Shin
Dongguk University, Korea

ABSTRACT

This article focuses on students' perspectives on various aspects of learning science at a distance, such as 'expectations,' 'learning outcomes,' and 'satisfaction'. Two foundation science courses offered by the School of Science and Technology at the Open University of Hong Kong (OUHK) were selected for the study. A series of in-depth interviews was carried out with students enrolled in these courses, followed by questionnaire surveys and field observations in order to validate and triangulate the interview data. The findings revealed that students placed a high value on practical work in science courses. Moreover, the more familiar with the course subject, the less difficulty they anticipate in learning science via distance education. Two significant correlations were also found, between the perception of practical work and satisfaction, and between the attendance rate and the perception of practical work with distance learning at OUHK. This research adds to knowledge of discipline-based distance education research in terms of empirical data in both qualitative and quantitative forms. Further investigation on this issue may help instructional designers and developed of science courses in the decision on various aspects of course design and development.

Key words: learning outcome, student's expectation, student's perspective of practical work, student's satisfaction

This paper is based on the outcomes of a research project "Learning Science at a Distance: Students' Perspective of Practical Work". The project was funded by the President's Advisory Committee on Research and Development at the Open University of Hong Kong. We divided the paper into six sections as background, literature review, objectives, sample and method, findings, and conclusion. In the section of findings, there are four sub-sections: expectations of practical work, learning outcomes, overall perceptions of the practical work, and significant differences in terms of students' familiarity with course subject. And the paper is closed with a suggestion of potential development.

BACKGROUND

Because of the nature of the discipline, science often involves students in first-hand experiences such as observation, measurement, or experiment, particularly in tertiary-level education (Kirschner, 1991). It can present a challenge, however, for distance education

institutions when offering science courses because of the fewer occasions for students to be on campus where laboratory facilities, relevant equipment, and teaching staff are provided (Holmberg & Bakshi, 1982). Nonetheless, the literature reveals impressive cases of teaching science at a distance, including such subjects as Physical Geology (McCartney, Kimball, & Swetname 1992), Chemistry (Kennepohl & Last, 2000), Human Biology (Naber & LeBlanc 1994), and Physics (Atan et al, 2002). Apart from basic academic reasons, ensuring that students engage in practical work becomes critical when it comes to the issue of credit transfer between educational institutions, as it can fairly represent the credibility of science courses (Kennepohl & Last 2000).

Much debate has been going on, however, as to the role, value or effectiveness of practical work not only in distance teaching settings but also in education in general (Watson 2002). Generally, the advantages of providing distance students with practical work include (1) reinforcing student's motivation towards subject matter, (2) generating within students positive attitude towards overall learning, and (3) intensifying interpersonal relationships with tutors and peer students. However, one inherent disadvantage of this option is related to cost and time availability on the part of students as well as teaching institutions and staff.

Despite its importance, the volume of research on science distance learning is relatively limited; and studies illuminating student perspectives on learning through practical work are particularly scarce. Investigating students' perspectives can be crucial to distance education research, however, given the plausible, or perhaps legitimate, expectations distance student can have regarding the arrangement of the instruction in such a way as to allow them more flexibility in managing time and place for learning. This understanding of distance students, along with the genuine need for research into the topic of science distance learning, compelled the investigators to undertake this research project.

LITERATURE REVIEW

Literature on the practical work involved in distance teaching and learning settings is more or less descriptive, reviewing a range of methods of its provision along with the strengths and weaknesses accompanying each method. In general education, there has been discussion of how science is and should be taught in a way to integrate numerous components and concepts embedded in the discipline. Taking the example of biology, Cunningham (1974) discussed the level of student's comprehension on biology concepts; Jungwirth (1975, 1977) and Deadman (1976) researched high school students' understanding of 'adaptation' and 'evolution'; and Maxwell's (1978) research has been concerned students at both undergraduate and post-graduate levels. Especially since the initiatives of Nuffield science and various US based science curriculum revolutions such as BSCS (Biology) and PSCS (Physics) of the 1960s, science educators have been keen on conceptual mastery that students can demonstrate as a learning outcome. A key focus here has been on the duration and design of practical work; and this concern remains and is intensified by the move towards distance education.

Given the inherent concern with 'distance' between students and educational institutions, Kember (1982) classified the practical work into three main methodologies according to the location of its primary action: residential school sessions, the use of local centres, and the home experiment kit. Each method has inherent advantages and disadvantages, and thus it becomes essential for distance education program providers to select one, or an array of methods, that can best suit their students under specific individual or environmental circumstances. Besides the analysis of target students, Holmberg & Bakshi (1982) suggested the nature of subject matter, pedagogical considerations of how the course should be taught, economic considerations, safety concerns, and available equipment of the institution as points of discussions when any laboratory activity, among other types of practical work, is prepared for distance students. The relative importance of these factors is, after all, dependent on one's point of view.

With the case of Open University of United Kingdom (OUUK), Ross & Scanlon (1995) also reviewed the ways of conveying practical elements of science courses to distance students, which includes home experiment kits, televisual media, computer mediated systems, and laboratory classes. Among these, it is the laboratory classes that always call for stronger justifications for their use than do other methods because of the extra concern with student and staff time. Kirschner (1991) also maintains that the residential school or classroom comes with a price not only financially but also strategically because of the OU's special position, reflecting a European distance education context, which needs to allow consideration of the philosophy of student autonomy associated with time and location for learning.

In fact, this cost concern has been a major issue of debate even in a conventional education setting where primary or secondary students learn the subject of science (Watson, 2002). Naturally, the cost issue involves discussions of the aims and effectiveness of practical work; that is, why do practical work? Amalgamating previous literature, Watson (2002) responds to that question with the following answers: to encourage accurate observation and description; to make phenomena more real; to arouse and maintain interest; and to promote a logical and reasoning method of thought. Besides, Watson notes that "Asking about the effectiveness of practical work for learning is like asking whether children learn by reading," suggesting that researchers ask more focused questions such as "what kind of practical works can be used to achieve particular aims" (p.57).

It is difficult, however, to find research studies that evaluate the kind of effect brought about by a specific method of practical work on distance student learning. Instead, relevant literature on science courses involving distance education method is rather illustrative, giving introductions into the overall programs, usually covering such topics as course design and development, methods employed for practical work, student characteristics, and problems and effectiveness found in a specific program. Garg, Panda, & Vijayshri's (1998) review is such an example, where they look at distance science programs from some selected distance education institutions, including the cases of OUHK and OUUK.

From a more focused angle, Kennepohl and Last (2000) review chemistry courses offered at Athabasca University (AU). Aiming to provide students with integral, accessible, and transferable chemistry courses, the AU chemistry course puts a strong emphasis on laboratory work, using mixed approaches through campus-based labs, regional labs, and home-study labs. Applications of technologies such as video, CD-ROM, Internet, and computer-mediated instruction have been also considered in the institution, but the authors make it clear that simulated experiments would not replace hands-on laboratory work. Rather, they believe that technical aids can be better used in preparing students for a real experience with laboratory work (p. 194).

OBJECTIVES

The research delved into following aspects of students learning science:

- expectations of practical work built into two OUHK courses offered by School of Science and Technology: A Foundation Course in Physics and Chemistry (S121) and A Foundation Course in Biology and Earth Science (S122), respectively;
- learning outcomes specifically derived from the practical work involved in each course;
- overall perceptions of the practical work;
- empirical relationships between the measured perceptions of the practical work and satisfaction with distance learning at OUHK.

SAMPLE AND METHOD

Prior to discussing research method, it is necessary to note basic features of the two courses about which the investigation was concerned. Both S121 and S122 are 10-credit foundation courses lasting for two semesters, starting from April and October of the year, respectively. For students who plan to take degree programs in Environmental Studies, Engineering including Mechanics and Materials, and Design for B.Sc or B.Sc Honors degree at OUHK, it is important to successfully complete one of foundation courses the School of Science and Technology offers. Also, it is often the case that a foundation course is the first course students get enrolled in when they come to OUHK for distance learning. For example, of 89 survey respondents among enrollments in the October 2001 presentation of the S122 course, 54.5 per cent said that the S122 was the first course they were taking from OUHK. This added some justification for researching these two foundation courses.

The project employed a time-series-interview, questionnaire survey, and field phenomenological observation as research methods. The pre-interview was carried out prior to the first Day school of the two courses so that students' expectation of various types of practical work was not contaminated or limited by experience. The field observation took place in either a science laboratory or a computer lab on the campus building for the S121 course. A half-day trip was included for conducting the field observation of the S122 course. The result of pre-interviews led to the development of a pre-survey questionnaire, which was mailed to all enrolled students. Following up with the pre-interviewee students, post-interviews were arranged after students completed the Day school activities. The post-interviews were conducted within a relatively short period of time after the Day school, before student reflections of the experience withered away. Amalgamating the results of the post-interviews,

a questionnaire was developed for a post-survey on each course to get overall evaluation of the practical work students had undertaken during the semester.

FINDINGS

Expectations of Practical Work

The following are the major findings from the above interviews, field observation and surveys to the research questions. Concerning the expectations of practical work built into S121 and S122 (see Table 1), it was found that most surveyed students (97.9%) thought it was essential for a science course to include practical work even though the course materials were delivered in a distance mode of education. Nearly three-quarters (71.7%) of surveyed students expected that it would be more difficult to learn science via distance education than the case of face-to-face, and 80.4% didn't think that practical work could be replaced by computer simulations or other virtual components that did not require a face-to-face class. However, 57.8% thought that it was more challenging to learn science via distance education than the case of other subjects related to Social Sciences or Humanities (see Table 2).

Table 1. "I think it is more difficult to learn science via distance education than the case of face-to-face"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	13	27.7	28.3	28.3
	Yes	33	70.2	71.7	100.0
	Total	46	97.9	100.0	
Missing System		1	2.1		
Total		47	100.0		

Table 2. "I think it is more challenging to learn science via distance education than the case of other subjects related to Social Sciences or Humanities (e.g., Economics, History, Language, Law, Management, etc)."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	40.4	42.2	42.2
	Yes	26	55.3	57.8	100.0
	Total	45	95.7	100.0	
Missing System		2	4.3		
Total		47	100.0		

Table 3. "I think it is essential for a science course to include practical work even though the course materials are delivered in a distance mode of education"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	2.1	2.1	2.1
	Yes	46	97.9	97.9	100.0
	Total	47	100.0	100.0	

On the other hand, most of the surveyed students (97.9%) think that it was essential for a science course to include practical work even though the course materials are delivered in a distance mode (see Table 3). And about 80% of surveyed students didn't think computer simulations or other virtual components could replace practical work (see Table 4). The above data reflects that practical work is highly valued as an element in science course, even in distance learning mode.

Table 4. "I think that practical work can be replaced by computer simulations or other virtual components that do not require a face-to-face class"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	37	78.7	80.4	80.4
	Yes	9	19.1	19.6	100.0
	Total	46	97.9	100.0	
Missing System		1	2.1		
Total		47	100.0		

Learning Outcomes

Table 5. Learning Outcomes

Statements	N	Mean	SD
The lab-session brought me a new perspective of learning science.	74	3.70	0.86
The lab-session helped me prepare for examinations.	74	3.14	0.82
The lab-session helped me complete an assignment.	74	3.50	0.83
The lab-session helped me learn how to use experiment tools.	74	4.07	0.82
The lab-session helped me understand the course material better.	74	3.64	0.84
The lab-session helped me sustain my interest in the course subject.	74	3.74	0.76
The lab-session made the whole course more interesting.	74	3.72	0.88
The lab-session was a special experience itself.	74	3.81	0.89
The lab-session helped me interact with my classmates.	74	3.77	0.67
The lab-session helped me interact with my tutor.	74	3.85	0.72
The lab-session helped me interact with my CC.	74	3.07	1.06
Valid N (listwise)	74	3.64	0.83

As for the learning outcomes specifically derived from the practical work (see Table 5), (from 1=Strongly Disagree to 5=Strongly Agree), the mean of overall learning outcomes of surveyed students from the two courses was 3.84 with SD=0.8, while it was higher derived from the field trip in S122 (M=4.14; SD=0.73). The students from S122 thought the field-trip was a special experience itself (M=4.36, SD=0.69) and made the whole course more interesting (M=4.44, SD=0.78). The field trip helped them sustain their interest in the course subject, made them keen on environmental issues, helped them view the Hong Kong's natural environment afresh, assisted in understanding the course material better and completing an assignment, even though the usefulness in preparation for the examination was not relative high (M=3.67, SD=0.9). As for the lab session, students thought that it helped them learn how to use experiment tools (M=4.07; SD=0.82) and interact with their tutor (M=3.85, SD=0.72). As with

the field trip, the usefulness of the lab session in the preparation for examination was relative lower ($M=3.14$, $SD=0.82$).

Overall Perceptions of the Practical Work

With regard to the overall perceptions of the practical work (see Table 6), students placed a high value on practical work in science courses. There was a direct relationship between the attendance rate and the perception of the practical work. Furthermore, in weighting the relative difficulty of learning science via distance education compared to that of face-to-face education, the surveyed students found it more difficult than expected. The mean of difficulty increased from 3.21 to 3.64 between before and after the course. The difficulty level was on a 1 to 5 scale, from a lot less difficult to much more difficult. The same situation happened when they weighed the relative difficulty of learning science via distance education compared to that of learning Social Sciences or Humanities. There was also an increase in weighing difficulty level from 3.14 to 3.47 after completing the course. It was found that the satisfaction level on the arrangement of the practical work in the two courses was moderate. ($M=3.37$, $SD=0.88$). Time allowed for individuals to raise questions to tutors was the item achieving highest satisfaction level ($M=3.46$, $SD=0.88$), while the starting time (6:30 p.m.) of lab-sessions during weekdays was rated with least satisfaction ($M=2.99$, $SD=1.22$).

Table 6. Overall Perceptions of the Practical Work

Statements	N	Mean	SD
Time duration of compulsory lab: 3 hours	74	3.50	0.86
Time duration of optional lab: 3 hours	74	3.55	0.76
Date arrangement of compulsory long lab: Sunday	73	3.49	1.02
Date arrangement of optional lab: weekdays	74	3.31	0.96
Group size in compulsory lab	74	3.35	0.73
Group size in optional lab	74	3.39	0.74
Time allowed for a group discussion during a lab-session	74	3.32	0.81
Time allowed for individuals to raise questions to tutors	74	3.46	0.88
Starting time (6:30 p.m.) of lab-sessions during weekdays	74	2.99	1.22
Valid N (listwise)	73	3.37	0.89

Significant Difference

There is a statistically significant difference between a group saying "Yes" and a group to "No" in item I in terms of their familiarity with the course subject (see Table 7). The more familiar with the course subject, the less difficulty they anticipate in learning science via distance education. Previous education, sex, previous experience with distance learning did not make such a difference. Moreover, the research found that there was a significant direct relationship, according to a 2-tailed correlation test, between the measured perceptions of the practical work and satisfaction with distance learning at OUHK.

CONCLUSION

This research strengthens the knowledge base of discipline-based distance education research by adding empirical data, in both qualitative and quantitative forms, revealing what students think of practical work, what they actually learn from it, and how it is integrated into overall course design. Although this knowledge is specifically relevant to the selected OUHK

students, it may contribute to developing and offering science courses using distance education by providing educators or institutions with some practical observations and considerations.

The research does not only provide information on the course design of science subjects at OUHK, but also generates the need for further investigation on the use of the web-based interactive learning system. For example, computer simulations or other virtual components without face-to-face can satisfy what the students' needs from a face-to-face lab session. But can web-conferencing and virtual face-to-face interaction replace or satisfy such needs? Further investigation on this issue may help instructional designers and developers of the science courses in the decisions on various aspects of course design and development.

Table 7. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. 2-tailed	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
I am familiar with the subject of physics	Equal variances assumed	1.266	.270	2.330	29	.027	.79	.339	.096	1.483
	Equal variances not assumed			2.363	28.900	.025	.79	.334	.106	1.474
I am familiar with the subject of chemistry	Equal variances assumed	1.022	.320	1.177	29	.249	.42	.357	-.310	1.150
	Equal variances not assumed			1.193	28.877	.243	.42	.352	-.300	1.141
Previous education	Equal variances assumed	.006	.940	.925	29	.363	.36	.386	-.433	1.147
	Equal variances not assumed			.923	27.650	.364	.36	.387	-.436	1.150
Sex	Equal variances assumed	.010	.921	.050	29	.961	.01	.169	-.338	.355
	Equal variances not assumed			.050	27.890	.960	.01	.169	-.339	.355
Have you taken any distance education course before?	Equal variances assumed	3.351	.077	1.036	29	.309	.18	.178	-.180	.550
	Equal variances not assumed			1.045	28.665	.305	.18	.177	-.177	.547

ACKNOWLEDGEMENT

This paper is based on the outcomes of a research project funded by the President's Advisory Committee on Research and Development at the Open University of Hong Kong. Other members of the team are Gordon Maxwell and C W Chan.

REFERENCES

- Atan, H., Rahman, A.Z., Azli, A.Z., Idrus, R.M., Ismail, G., & Saleh, M.N. (2002). Teaching of science courses in distance education: Comparative studies between audio-graphics and face-to-face. *Indian Journal of Open Learning*, 11(1): 41-49.
- Cunningham, P. (1974). *'A' level biology comprehension (Book 1)*. Glasgow & London; Blackie.
- Deadman, J.A. (1976). *The structure and development of concepts associated with the topic of evolution in secondary school boys. Ph D dissertation*. University of London.
- Garg, S., Panda, S., & Vijayshri (1998). Global perspectives on distance science teaching. In S. Garg, S. Panda, & Vijayshri (Eds). *Science the technology through open and distance education*. New Delhi: Aravali Books International LTD.
- Holmberg, R.G., & Bakshi, T.S. (1982). Laboratory work in distance education. *Distance Education*, 3: 198-206.
- Holsti, O.R. (1968). Content Analysis. In G. Lindzey & E. Aronson (Eds.). *The handbook of social psychology* (Vol. Two, pp. 596-692). Massachusetts: Addison-Wesley Publishing Company.
- Jungwirth, E. (1975). Preconceived adaptation and inverted evolution: A case of distorted concept formation in high-school biology. *Australian Science Teacher Journal*, 21 (2), pp. 95-100.
- Jungwirth, E. (1977). Should natural phenomena be described teleologically or Anthropomorphically? A Science Educator's View. *Journal of Biological Education*, 11 (3), pp. 191-6.
- Kember, D. (1982). External science courses: The practical problem. *Distance Education*, 3(2): 207-25.
- Kennepohl, D. & Last, A.M. (2000). Teaching chemistry at Canada's Open University. *Distance Education*, 21 (1): 183-197.
- Kirschner, P.A. (1991). *Practicals in higher science education: A study of the objectives and end-terms for practicals in distance and traditional educational settings*. Center for Educational Technology and Innovation OTIC, Open University of the Netherlands.
- Maxwell, G.S. (1978). *Adaptation: A study of biological concept. M.A. dissertation*. Leeds University.
- McCartney, K., D. Kimball, & Swetname, J. (1992). Teaching physical geology and laboratory courses by interactive television. *Journal of Geological Education*, 40: 367-72.
- Merriam, S. B., & Simpson, E. L. (1995). Chapter 6. Meaning and interpretation: Qualitative methods, *A Guide to Research for Educators and Trainers of Adults*, Malabar: Krieger Publishing Company, pp. 97-120.
- Naber, D. & LeBlanc, G. (1994). Providing a human biology laboratory for distance learners, *The American Journal of Distance Education*, 8 (2): 58-71.
- Ross, S. & Scanlon, E. (1995). *Open science: Distance teaching and open learning of science subjects*. London: Paul Chapman Publishing Ltd.

Stevenson, K., Sander, P., & Naylor, P. (1996). Student perceptions of the tutor's role in distance learning. *Open Learning, February*, 22-30.

Watson, R. (2002). The role of practical work. In M. Monk and J. Osborne (Eds). *Good Practice in Science Teaching: What research has to say*. Buckingham, Philadelphia, Open University Press: pp. 57-71.