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A study on the sources of, and approaches to, knowledge transfer for students majoring in mechanical engineering at vocational high schools in Taiwan

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ABSTRACT: The purpose of the study was to explore the sources, approaches and related factors concerning knowledge transfer that are possessed by mechanical engineering majored students at vocational senior high schools. The research methods included a literature review, interviews with experts, the nominal group technique and an online questionnaire survey. The sample subjects included 10 nominal group members and 1,500 randomly selected junior-year students enrolled at vocational high schools in Taiwan. The nominal group consisted of 10 members, including CEOs of mechanical engineering enterprises, college mechanical engineering professors, experienced departmental chairpersons and teachers in the field. The findings of the study indicate that the sources and approaches of students' knowledge transfer from the corporate world included site visits, on-the-job training sessions, exhibitions and presentations. In addition, the sources and approaches of students' knowledge transfer from schools included teaching resources, information technology, certification acquirement and participation in technical competitions. Finally, suggestions drawn from the results are presented and a model of vocational high school students' knowledge transfer is established.

INTRODUCTION

School is the foundation for industry when cultivating, educating and training people, whereas industry is the place for applying and implementing theories and knowledge. Both school and industry are tightly related and rely on each other. One of the primary goals of education is to guide students to be familiar with industry, as well as to teach them the latest knowledge and skills of industry. As a hot wave of knowledge management prevails in industry, the application of knowledge transfer becomes one of the most effective strategies to assist schools to reach these goals. Since knowledge transfer involves a series of learning procedures, when an individual or an organisation lacks knowledge, a knowledge gap is generated and the knowledge will need to be transferred from the outside [1]. In addition, knowledge transfer is not only an important procedure for creating knowledge, but also enables implicit and explicit knowledge to interact with each other in order to reach the goal of knowledge creation [2].

Knowledge transfer can be defined as the interaction between the knowledge supplier and knowledge receiver, and the goal of knowledge transfer can be reached by various means or tools [3-5]. In other words, knowledge transfer is a communication process itself, unlike products that can be freely delivered. Thus, reconstruction should be exercised and basic knowledge should be possessed when transferring knowledge.

Knowledge transfer consists of two major bodies, namely: knowledge provider and receiver. The knowledge provider should be capable or willing to convey implicit knowledge to the receiver and then deliver it to the receiver through speeches, paper documents and presentations to carry out knowledge transfer. Finally, the receiver can obtain knowledge by simulations, listening or reading. Knowledge transfer suppliers and receivers are the main subjects of knowledge transfer performance. Knowledge transfer can be performed through speeches, paper documents and presentations. Knowledge transfer receivers can then obtain knowledge through simulations, listening or reading.

Dixon proposed five models of knowledge transfer for exploring how knowledge transfer team conducted different types of knowledge transfer according to the similarities of missions and situations, the characteristics of missions and types of knowledge, which include serial transfer, near transfer, far transfer, strategic transfer and expert transfer [6]. Therefore, the key points of knowledge transfer are determined by the types of knowledge, levels of transfer and the amount of absorption.

While there is a knowledge gap that exists between students and schools or industry, students can obtain the latest knowledge and skills by utilising knowledge transfer strategies. In order to meet the rapid shifts and changes of industry and vocational high school curricula, it is particularly and extremely urgent and necessary to explore the sources, approaches and related factors of mechanical engineering majored students' knowledge transfer in vocational high schools.

According to the research background and motives stated above, the purposes of the study are as follows:

- To explore the sources of mechanical engineering majored students' knowledge transfer at vocational high schools;
- To explore the approaches of mechanical engineering majored students' knowledge transfer at vocational high schools;
- To explore the related factors of mechanical engineering majored students' knowledge transfer at vocational high schools.

METHODOLOGY

Literature review, an interview with experts, nominal group technique and an online questionnaire survey were employed in this study. First of all, an outline of the interview questions was developed from a literature review; five experienced experts from the mechanical industry were then interviewed. Afterwards, 10 experienced professionals, including professors, scholars and teachers in the mechanical engineering field were invited to participate in the nominal group discussion on the related topics, such as source contents and approaches for knowledge transfer for students majoring in mechanical engineering at vocational high schools. In doing so, an online questionnaire was developed based on the results of the nominal group discussion.

Finally, 1,500 students majoring in mechanical engineering at vocational high schools in Taiwan were randomly selected to fill out the online questionnaire. A total of 323 valid responses were collected for the statistical analysis in order to explore the approaches and related factors of mechanical engineering majored students' knowledge transfer at vocational high schools.

RESULTS AND FINDINGS

The Results of the Interview with Experts

An in-depth interview was conducted with five Chief Executive Officers (CEOs), managers and professional experts from the mechanical industry in Taiwan in order to discuss key issues, such as successful knowledge transfer cases and models in industry, the factors and approaches for knowledge transfer, plus strategies and methods to transfer knowledge from industry to students at vocational high schools. The results of the interview discussion are detailed below.

Factors for successful knowledge transfer in industry were ascertained to be as follows:

- Establishing a sound relationship and planned proper cooperation strategies between schools and industry;
- Obtaining managerial support and good inner-communication relationships with others;
- Seeking technological support and planning seed training;
- Building good computer databases;
- Improving professional English and becoming acquainted with the latest technological knowledge.

Influential factors impacting knowledge transfer from industry to students majoring in mechanical engineering at Taiwanese vocational high schools were determined to be as follows:

- Changes to the educational system;
- Adjustments in social value;
- The reduction and shortage of educational funding and budgets;
- Biased curriculum planning at vocational high schools;
- A fault of continuation emerged from teachers' practical experience;
- The cultivation of the literacy of students' English and computer skills;
- The level of student participation in technical appraisals and competitions.

Results of the Nominal Group Discussion

The nominal group discussion consisted of 10 senior experts, professors and teachers who had gathered to discuss six key issues, including students' knowledge sources from industry, schools and individuals, the approach of corporate knowledge transfer to schools and individuals, and school knowledge transfer to individuals. The results of the discussion, summarised in order of importance, are listed below:

1. Sources of corporate knowledge: publishers, the mechanical industry (material manufacturing, processing, packing, assembling and measuring) and professional mechanical networks;
2. Sources of school knowledge: teachers, course materials (textbooks, instruction and practicum), technical appraisals, library (books and magazines, journals and electronic databases) and competitions (on-campus and off-campus competitions, technical competitions, creative competitions and science exhibitions);
3. Sources of individual knowledge: personal value (mechanical value) and professional knowledge learning (professional techniques, knowledge and attitude);
4. Approaches of knowledge transfer from corporations to schools: observations, on-site visitations, the Internet, on-the-job learning and training, periodicals, industry cooperation and professional groups;
5. Approaches of knowledge transfer from schools to individuals: aggressive activities and behaviour (students aggressively seek knowledge to understand, simulate, apply and create knowledge).

Statistical Results of the Questionnaire Survey

A total of 1,500 students were randomly selected from the junior year of vocational high schools nationwide across Taiwan in order to conduct the online questionnaire survey. *SPSS* version 10.0 was utilised to analyse a total of 323 valid responses from the online survey questionnaire. The statistical results of the survey are summarised below.

A one-sample t-test of the items revealed the following:

- Sources of corporate knowledge: These consist of eight categories, including mechanical engineering research and development, mechanical engineering human resources (educational training), mechanical engineering professional software, mechanical engineering (materials manufacturing, processing, packing, assembling and measuring), mechanical engineering service (marketing, repair, maintenance and inspection), mechanical engineering professional network, mechanical engineering exhibitions (eg museums and invention exhibitions) and publishing. A Likert seven-point scale was administered with a median at the fourth point. The statistical results indicate that all categories reached a significant consensus from the one-sample t-test;
- Sources of school knowledge: These comprise 15 categories, including teachers, school administrators, student peers, community and students' parents, the Internet, library resources (eg books, magazines, journal articles, electronic databases), school curricula (eg materials, instruction and practicum), professional groups, school club activities, industry cooperation, speeches (eg professionals, alumni, professional study camps), off-campus visits, exhibitions (eg technical presentations,

science exhibitions), competitions (eg on-campus and off-campus competitions, technical competitions, creative competitions, science exhibitions). The results of the one sample t-test indicate that all categories reached a significant consensus;

- Individual knowledge cultivation: These consist of six categories, including personal value (mechanical value), knowledge of professional knowledge and skills learning (ie professional techniques, knowledge and attitude), knowledge of interpersonal skills learning (human and culture literacy, temper control, failure tolerance, inter-personal relationships, communication skills), learning of professional and life knowledge (eg vocational morals, public safety and hygiene, cultural literacy, time management, learning attitude), learning of professional knowledge practice (eg on-the-job training, creative abilities, goals and norms, beliefs control, meta-cognition, added value, analysis ability) and knowledge of living with ecology learning (caring for humans and ecology). The results of the one sample t-test indicate that all categories reached significant consensus;
- The approaches of knowledge transfer from a corporation to the school: The results show that there are 12 approaches for transferring knowledge from a corporation to the school, including lectures, professional group instruction and guidance, industry cooperation, the Internet, interviews (visits), exhibitions and presentations, on-the-job training, benchmark learning, the study of periodicals, seminars, workshops, technological transfer and cooperation for mutual benefit. The results of the one sample t-test indicate that all categories reached a significant level of consensus;
- The approaches of knowledge transfer from the school to the individual: There are two approaches in this category, including aggressive learning (students aggressively seek knowledge and to understand, simulate, apply and innovate it) and passive learning (techniques and marketing knowledge learned from instructors). The results of the one sample t-test indicate that all categories reached significant consensus;
- The approaches of knowledge transfer from the corporation to the individual: There are 10 approaches for the corporate transfer of knowledge to individuals, including lectures, professional group instruction and guidance, industry cooperation, the Internet, visitations (observations), exhibitions and presentations, the study of periodicals, seminars, workshops, vocational training and technical appraisals, and certification acquirements. The results of the one sample t-test indicate that all categories reached significant consensus.

Multiple Regression Analysis

A multiple regression analysis was employed in this study in order to determine whether the 10 approaches of knowledge transfer from the corporate level to the individual influenced an individual's knowledge transfer. The item *the study of periodicals*, with a 7.7% explanation, obtained the best predictability among the predictable variables. The standard regression formula is presented below.

Frequencies of aggressively obtaining mechanical knowledge from a corporation = 0.012 x lecture + 0.063 x professional group instruction and guidance + 0.025 x industry cooperation- 0.026 x Internet + 0.108 x visitations + 0.006 x exhibitions and presentations + 0.252 x periodical study - 0.169 x seminars - 0.068 x vocational training + 0.075 x examination and certification.

A multiple regression analysis was utilised in this study in order to identify whether or not the approaches of knowledge transfer from the school to the individual have a significant impact upon knowledge transfer behaviour. The item, *aggressive learning*, obtained a value of 11.5%, indicating a fine predictability level among the predicted variances. Its standardised regression formula is presented below.

Frequencies of aggressively obtained mechanical knowledge from school = 0.310 x aggressive learning (students aggressively search for knowledge and understand, simulate, apply and innovate) + 0.096 x passive learning (students' passively obtained market knowledge and skills from school teachers).

The Structural Equation Model

Figure 1 shows the standardised parameter coefficient of the modified structural equation model.

The structural equation model was administered with *LISREL* 8.52 in this study. The statistical results are listed in Table 1. The results show that the GFI and AGFI values are 0.95 and 0.91, respectively, which are greater than 0.90, indicating that the observed data can be explained mostly by the hypothesised model. In addition, the value of the RMSEA is 0.069, indicating that the theoretical model obtained a good fit. The results of the comparative fit index show that all indexes (NNFI=0.97, NFI=0.96, CFI=0.98 and FI=0.95) are not only greater than 0.90, but also exceed 0.95, identifying that the entirety of the model is fine. In terms of the simple fit index, the PNFI, PGFI, CN and normed chi-squared values are 0.63, 0.52, 200.37 and 2.53, respectively, denoting that all indexes fit the standard. That is, the statistical results suggest that the model is acceptable. Generally speaking, all indexes of the categories have passed the test, signifying that this model has sound construct validity. As such, this is a fine fit model.

Table 1: Fit indexes of the model.

Fit Index	
χ^2 (df)	91.31 (36)
NCP	55.31
GFI	0.95
AGFI	0.91
SRMR	0.041
RMSEA	0.069
ECVI	0.47
NFI	0.96
NNFI	0.97
CFI	0.98
IFI	0.98
RFI	0.95
PNFI	0.63
PGFI	0.52
AIC	151.31
Critical N	200.37

Regarding the evaluation of construct model, Table 2 shows that $\gamma 1$ obtained the standardised parameter value of 0.15 and the t value was 0.84, which was not statistically significant. The statistical results indicate that the sources of corporate

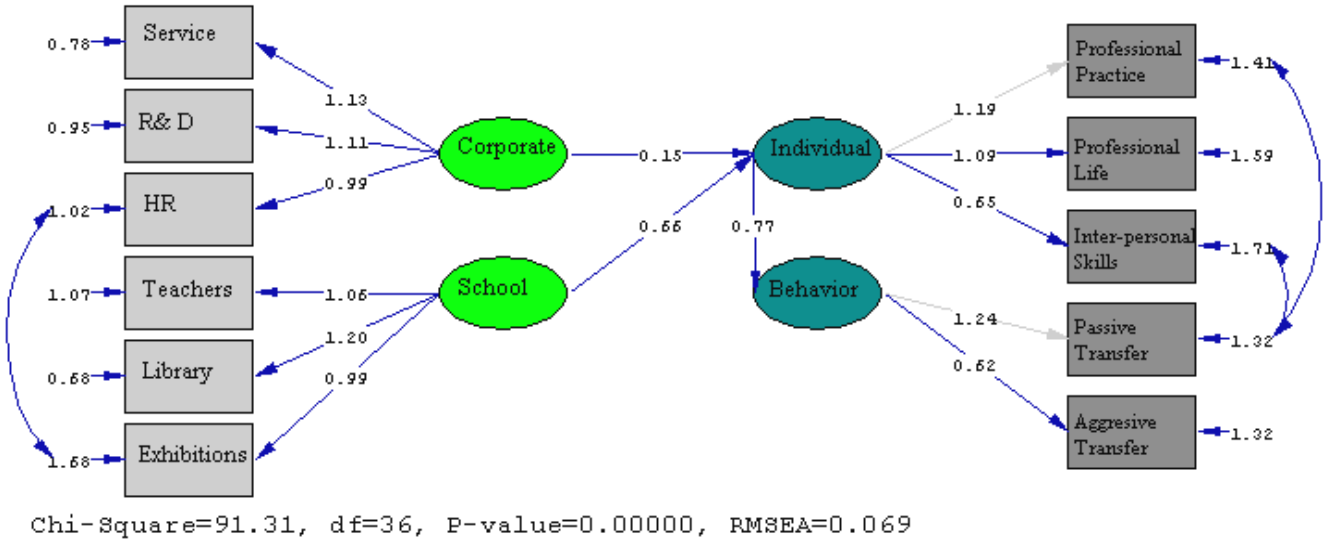

Figure 1: Standardised parameter coefficient of the modified structural equation model.

knowledge did not have a positive and direct influence on the contents of individual knowledge. In addition, the obtained γ2 value gave a standardised parameter value of 0.66 and a t value of 3.51, which were found to be statistically significant, indicating the sources of school knowledge have a positive and direct influence on individual knowledge content.

In addition, the results also identify that individual knowledge content has a positive and direct influence on individual knowledge transfer.

Table 2: Parameter estimation of the model.

Parameter	Non-Standardised Parameter Value	Standard Error	t value	Standardised Parameter Value
λ1	1.13	0.07	15.67*	0.79
λ2	1.11	0.08	14.73*	0.75
λ3	0.99	0.07	13.43*	0.70
λ4	1.06	0.08	13.84*	0.72
λ5	1.20	0.07	16.60*	0.82
λ6	0.61	0.09	11.24*	0.61
λ7	1.19	--	--	0.71
λ8	0.65	0.12	9.42*	0.65
λ9	0.65	0.10	5.72*	0.44
λ10	1.24	--	--	0.73
λ11	0.62	0.11	5.68*	0.47
γ1	0.84	0.18	0.84	0.15
γ2	0.66	0.19	3.51*	0.66
ß1	0.77	0.11	7.15*	0.77

* $p < 0.05$

CONCLUSIONS

The successful factors identified in the study for knowledge transfer from a corporation include establishing a good relationship with industry and planning industry cooperation strategies, obtaining support from administrators and possessing good interpersonal communication, seeking technical support and seed training, establishing abundant computer data, strengthening professional English knowledge and acquiring the latest technological knowledge.

Factors that affect knowledge transfer from a corporation to vocational high school students include changes to the education system, adjustments in social values, the shortage and reduction of an educational budget, the curriculum design and plan, the continuity of teachers' experiences, the cultivation of students' English and information literacy, and the participation in competition and certification of technical skills.

The sources of vocational high school students' corporate knowledge covered research and development activities in the mechanical engineering industry, human resource development of the mechanical engineering industry, professional mechanical engineering software for industrial mechanical manufacture, mechanical engineering service, mechanical engineering professional networks, mechanical engineering exhibitions and publications.

The sources of vocational high school students' school knowledge included teachers, school administrators, student peers, parents and the community, the Internet, libraries, the school curriculum, professional groups, school club activities, industry cooperation, speeches, visits, workshops, exhibitions, competitions and technical appraisals.

An individual's cultivation of knowledge included personal value, knowledge of the profession and skills learning, knowledge of interpersonal skills, learning professional and life knowledge, learning professional knowledge practices and knowledge of living with ecology.

The approaches for knowledge transfer from a corporation to the school incorporated lectures, professional group instruction and guidance, industry cooperation, the Internet, interviews, exhibitions and presentations, on-the-job training, benchmark learning, the study of periods, seminars, technological transfer and cooperation for mutual benefit.

The approaches of knowledge transfer from the school to the individual include aggressive learning and passive learning.

The approaches of knowledge transfer from a corporation to the individual covered lectures, professional group instruction and guidance, industry cooperation, the Internet, visits,

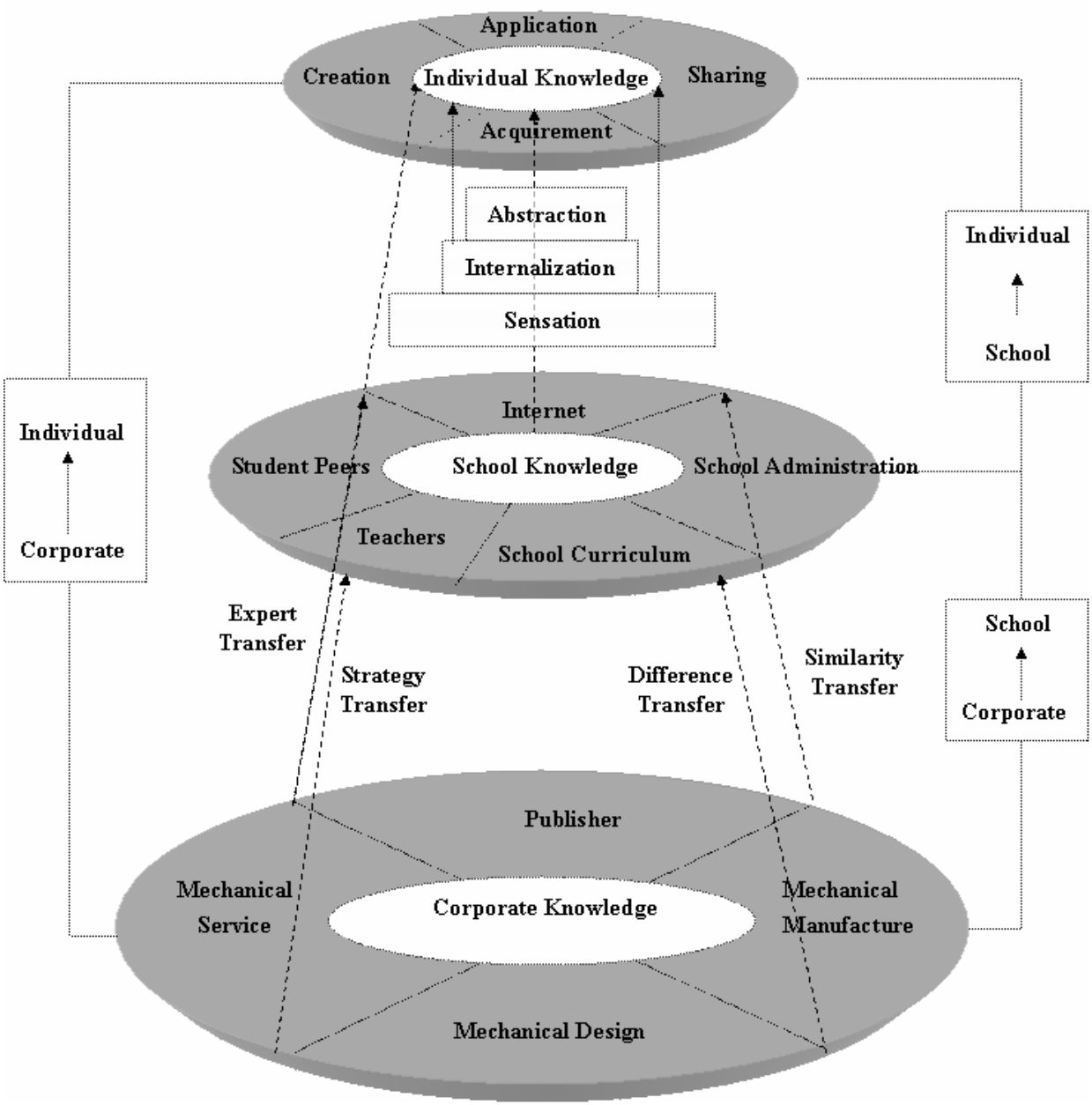

Figure 2: The model of mechanical engineering majored students' knowledge transfer at vocational high schools.

exhibitions and presentations, the study of periodicals, seminars, vocational training, and examination and certification.

The results of multiple regression analysis indicate that the prime approach to aggressively obtain mechanical engineering knowledge from the corporation is via the study of periodicals. In addition, the main approach to obtain mechanical engineering knowledge from the school is through aggressive learning.

The results of the structural equation model analysis suggest that the source of corporate knowledge does not have a positive and direct influence upon the individual's cultivation of knowledge. In contrast, the sources of school knowledge have a positive and direct influence on the individual's cultivation of knowledge. In addition, it was found that the individual's cultivation of knowledge has a positive and direct influence on the individual's knowledge transfer.

The model for knowledge transfer of students majoring in mechanical engineering at vocational high schools is shown in Figure 2.

SUGGESTIONS

Vocational high schools should cooperate with industry in order to offer more practical and hands-on courses to students. This will increase students' knowledge transfer, including their paying more visits to factories or by firms holding more product exhibitions, providing business workshops and vocational training sessions to students, as well as cooperating with industry. In addition, the Web site functions of schools need to be improved so that they provide more information on business experiences, product characteristics or present the results of R&D from journals and periodicals.

Students' English ability and proficiency should also be strongly considered and enhanced. In addition, school libraries should increase their stock of books, magazines, journals and periodicals, and should expand their electronic databases.

Furthermore, teachers should be encouraged to attend more workshops and training sessions so as to enhance their teaching

effectiveness. Moreover, schools should organise professional clubs and encourage students to participate in them. Finally, schools should offer students more lectures from industry figures or corporate visits, as well as require students to attend technical competitions or appraisals.

The cultivation of vocational high school students' knowledge includes personal value, learning professional knowledge, learning interpersonal and social skills, learning professional and life knowledge, learning about professional practices, and learning ecological knowledge. In order to increase students' knowledge transfer, teachers should encourage students to aggressively seek, understand, simulate, apply and innovate such knowledge.

The results show that the sources of school knowledge have a positive and direct influence on an individual's knowledge cultivation and individual's knowledge transfer behaviour. Thus, the sources and approaches of knowledge at schools and corporations need to be enhanced and reinforced in order to improve students' knowledge transfer.

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