Innovation in *Ergonomics* course teaching, based on knowledge management

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ABSTRACT: *Ergonomics* is a fundamental course in product design majors. The situation and problems in course teaching are summarised in this article, as well as those features and usability of knowledge management that could be applied in the teaching. Hence, knowledge management, which is applied successfully in business, is now introduced into course teaching. The teaching of *Ergonomics* is discussed based on knowledge management theory; and progressive teaching content, combined with a modular course structure, is outlined. The course is practical and assignment-driven with group collaboration, while making use of the network course platform. The feasibility was demonstrated through implementation and feedback from students.

INTRODUCTION

With the development of technology, the era of the knowledge economy has arrived. The fundamental problem in teaching a product design major is how to respond to the rapid expansion of knowledge. Ergonomics aims to train students to design products centred on human needs. Students cannot learn only by being taught theory, concepts and methods. They also need to learn by actually designing. Ergonomics theory must be utilised in practice by the students to achieve the teaching goals set.

Knowledge management emphasises gaining, storing, studying, sharing and innovating in the use of knowledge. It has been successfully applied to business to improve the productivity, flexibility and creativity of groups or individuals. In teaching, course resources can be integrated using knowledge management. The resources can be categorised and ordered according to teaching needs, which benefits sharing and knowledge accumulation. Blending knowledge management into an ergonomics course can benefit knowledge delivery and students' creativity.

KNOWLEDGE MANAGEMENT AND TEACHING

Knowledge is at the heart of teaching, which is concerned with the transmission and delivery of knowledge. In knowledge management terms, teaching can be seen as a flow of knowledge, which raises the question of the most effective way to deliver the knowledge. Ikujiro Nonaka sees knowledge acquisition as a process that converts explicit to implicit knowledge [1][2].

Explicit knowledge includes definitions, concepts, theories and principles. By comparison, implicit knowledge can only be elucidated through examples, given its intangibility and abstraction, e.g. by experience, ways of thinking and values. Knowledge transfer between teachers and students determines the quality of the teaching [3]. Teachers need to deliver explicit knowledge, including concepts, theories or methods, and implicit knowledge, such as self-practice and experience. The implicit knowledge helps students to convert the explicit knowledge into problem-solving abilities.

The *Economy Based on Knowledge* report from the OECD (Organisation of Economic Co-operation and Development) classified knowledge into four categories: what, why, how and who [4].

All four types of knowledge should be covered in higher education courses. Students will learn explicit knowledge from the teacher, i.e. *what* and *why* including truths, theories and rules. However, implicit knowledge concerning *how* or *who*, cannot be easily gained through teaching [5]. This is because such knowledge relies on accumulated knowledge, as illustrated in Figure 1.

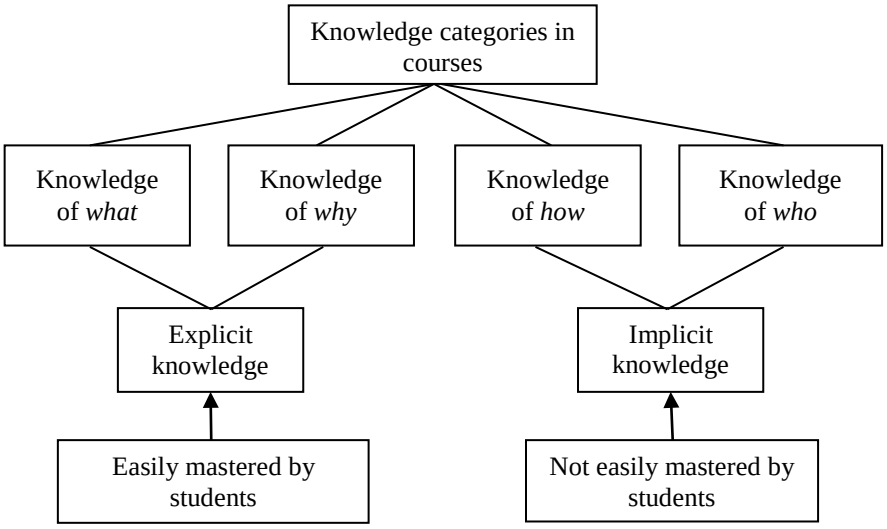

Figure 1: Course knowledge categories.

Therefore, when teaching explicit knowledge, teachers should also explore intuitions, ideas or inspirations that convert explicit to implicit knowledge. This is the key to introducing knowledge management into ergonomics teaching.

ERGONOMICS TEACHING

Ergonomics is concerned with an efficient work environment [6]. It is one of eight product design majors set by the Ministry of Education's Industrial Design Commission of Teaching Instruction. The major teaching objectives of the course emphasise both theory and practice. The course requires students to ergonomically design in accordance with relevant guidelines. It also covers *human-machine-environment* system design and provides practical guidance for *human-centred* design. The aim is to build an environment suitable for a human-controlled and harmonised *human-machine-environment* of high efficiency [7]. The knowledge in the Ergonomics course will recur in many other courses of product design and, hence, is very important for students.

Current Situation and Problems in Teaching Ergonomics

Ergonomics or related courses are part of most university majors of product design, but there are problems with the teaching, viz.:

- Teaching content and structure:

  The course pays most attention to basic theories, principles and even formulae. This bores students, especially art students, even causing them to dislike the course.

- Not enough class hours to cover the knowledge:

  As an interdisciplinary course, Ergonomics covers human factors, technology and the environment. Hence, the subject holds a great amount of knowledge and content. Generally, the 32 hours of class time allocated is very deficient.

- Textbooks stress theory rather than practice:

  Textbooks usually are adapted from human engineering books. The content is too wide and lacks examples. The teaching objective cannot be attained because students cannot apply the theories to actual design.

- Unsuitable teaching plans:

  Teaching plans are usually not suitable for product design majors. Components are independent and not closely related. The lack of class hours and the theoretical orientation of the course will not inspire students [8].

- Isolated course not correlated with other courses:

  Even though related to several other main courses, the course did not draw the attention and interest of students. The teaching needs to be better correlated with other core courses.

To address problems in teaching, modified teaching practices have been introduced based on knowledge management. These aim to make the teaching of product design *human-centred* by emphasising designs centred on product usability and human nature. Students should end up knowing *why*, *what*, *how* and *who*. Basic teaching practice concepts are illustrated in Figure 2.

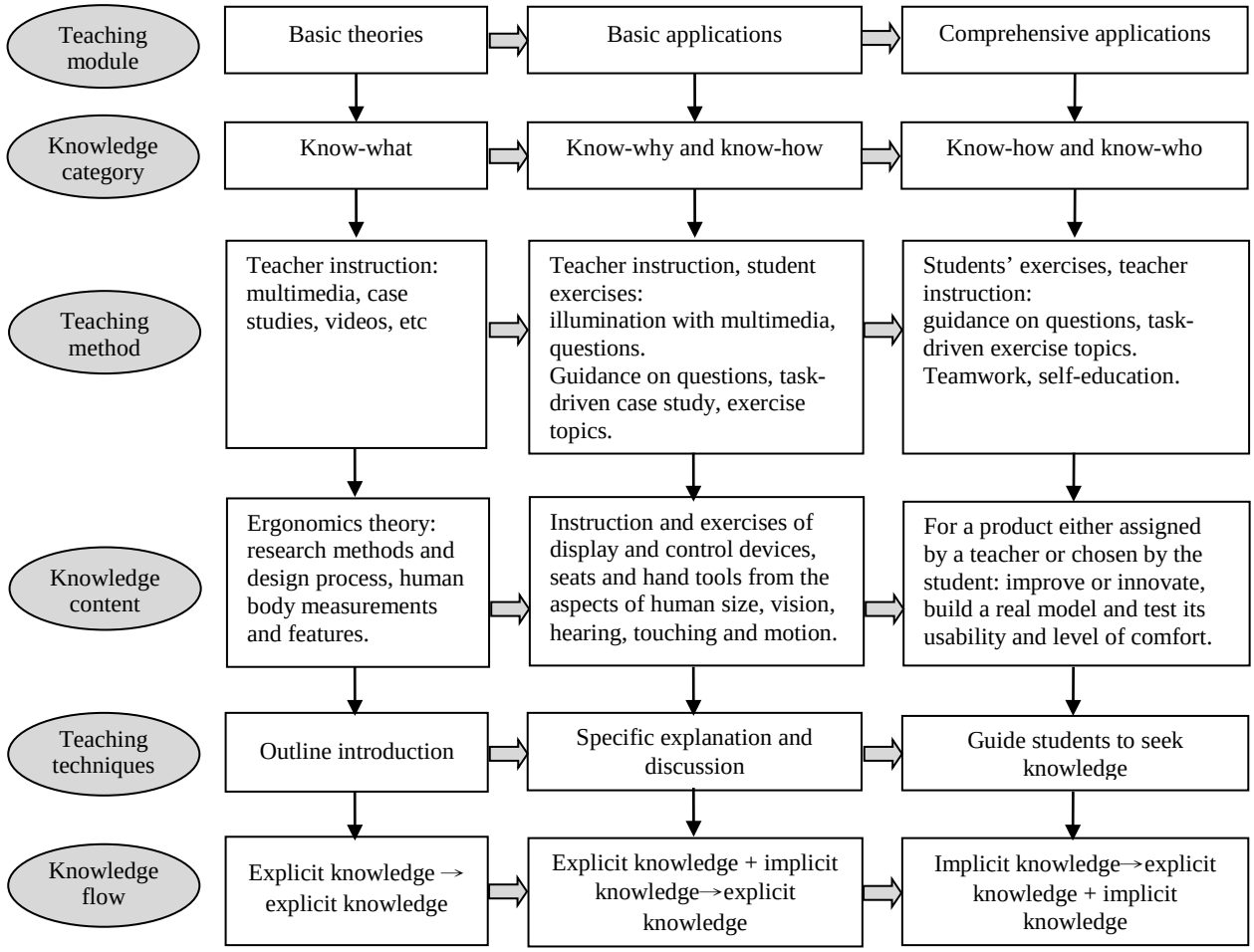

Figure 2: Ergonomics teaching based on knowledge management.

Modular Course Structure and Teaching Content

Leonard-Barton posits that abilities are in interconnected knowledge groups [9]. Guided by this, the course structure was divided into three modules, viz. basic theory, basic applications and comprehensive applications:

- In the basic theory module, the teacher introduces ergonomics theory including research methods, the application design process, human body measurements and human perception. This knowledge is of *what*.

- In the basic application module, knowledge of *why* and *how* become important. Teacher instruction is combined with student exercises. Students study display and control devices, seats and hand tools, from the aspect of human size, vision, hearing, touch and human motion.

- In the comprehensive application module, student exercises are given first place. Students are asked to improve or innovate a product to build a real model and test it for usability and comfort. This employs knowledge of *how* and *who*.

The teaching is a progressive process, from easy to hard; from methods to thinking; then, to understanding and, finally, to innovation. Students will be trained in the transition from knowing to understanding; from memorising to utilising; and from applying to innovating. Hence, they convert explicit knowledge into implicit knowledge.

Passive Study to Active Study

Constructive study theory states that, apart from teacher instruction, knowledge can be gained from the assistance of others, from appropriate material or constructed by the senses. Only when active study replaces passive study, can the student properly understand explicit knowledge and better generate implicit knowledge.

Ergonomics is a subject with an emphasis on the *human*. Ergonomics can be used to address problems of products that are difficult to use or inconvenient or irrational or unsafe. To encourage students to be positive and involved, the basic application and comprehensive application modules should be task-driven and involve teacher guidance on answering questions.

Students' interest and motivation can be provoked by questions, followed by classroom self-study of assigned jobs and tasks. The teacher's role is to guide the students to discover, study, explore and solve problems. Completing a task involves first of all knowledge of *what*; to analyse requires knowledge of *why*; to solve requires knowledge of *how* and *who*.

Team Co-operation, Knowledge Sharing and Knowledge Accumulation

Knowledge generation may be by the individual, but it usually depends on teamwork. In companies, knowledge is often generated in *brain-storming* sessions. Knowledge management theory stresses that individual implicit knowledge can be converted into explicit knowledge shared between groups through discussion, which is good for creating ideas [10]. Therefore, by using teamwork in the phases of carrying out application tasks, students can generate new ideas and accumulate knowledge. In this way, knowledge sharing is natural. The teacher should create an environment with targets and challenges for each group. The teacher should encourage students to be independent, but also co-operative and collaborative.

The Network Course Platform and Indirect Class Hours

Students rely on knowledge provided by the teacher. Due to time limits, however, not every course task can be done in class, and the teacher probably will not be able to answer every question. Nowadays, basically every university has its own on-line network course platform by which the effective class hours can be expanded significantly. Students themselves can seek answers to questions related to knowledge of *what*, *how* or *who*, thereby, enhancing their self-study and problem-solving abilities. Students can also launch questions or leave messages for teachers when facing problems they alone cannot solve. Hence, the network course platform will continue to benefit students in future ergonomics courses.

CONCLUSIONS

Being *human-oriented* is one of the principles of product design. The Ergonomics course aims to instil this principle in students and develop their problem-solving abilities. However, the current teaching does not reach this goal due to limitations and problems in the teaching. These can be addressed by introducing knowledge management, and implementing reforms based on a modular course structure and progressive course content. By these means students can master explicit knowledge, the generation of implicit knowledge and the problem-solving abilities required for the Ergonomics course.

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