Computer-Assisted Instruction in Parasitology: A Cross-Over Design

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We report here the results of the study using CAI compared to the hard copy for study of lessons in parasitology. We evaluated the CAI compared to hard copy lessons in 60 students, attending the third-year parasitology course at Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. The students were randomly divided into two groups (30 each). The lessons tested were Ascaris lumbricoides and Entero- bius vermicularis, which were prepared as CAI and hard copy form. Using a cross-over design, the first group was provided CAI form on the topic of A. lumbricoides, then switched to hard copy form on the topic of E. vermicularis. The second group was provided hard copy form on the topic of A. lumbricoides, then switched to CAI form on the topic of E. vermicularis. After 30 minute reading, the 10-multiple choice question test was provided for each topic. There was no significant difference of the scores between 2 groups. The most students (91.67%) had more satisfaction when using CAI compared to hard copy in terms of easy to use, convenient to use, less time consuming, more understandable, more attractive to read, and less stress for study. There were 32.8% students complaining that reading hard copy was boring. Other comments were stress when reading (2%), more difficult (17.2%) and more time needed to search specific information (17.2%), and wasting papers (17.2%). However, 58.6% still complained problems when using CAI. About 25% had physical discomfort (eg. Headache, eye pain), and 25% had difficulty to access to use CAI (eg. no computers available, problems with computer or network error). We suggested that instructors should create and improve CAI lessons in biomedical sciences both in quantity and quality (eg. content with details, pictures, narrations).

Keywords: Computer-assisted instruction, Parasitology


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There is a revolution underway in education that involves a shift from the traditional lecture style of information toward a more active style of learning(1). Many educators now believe that students must actively participate in the learning process for information to be truly understood and retained. Coincident with this revolution, there is an increased understanding that the body of knowledge in most professions, including biomedical sciences, has become too large to retain in the brains of individuals. Therefore, these concepts have opened the door to innovative, computer-based educational techniques.

Self-directed learning (SDL) has been adopted to education in subjects in biomedical sciences. SDL will build up the knowledge and help the study outcome more efficient. Finally, individuals will be able to progress their study by themselves. One of the important tool that helps SDL among students is Computer aided/assisted instruction (CAI). Computers have been used to assist education by gathering all informations and data in the format that can be retrieved rapidly and easily, depending on the software used. Therefore, each individual can use the computers for SDL efficiently. In spite of enthusiastic endorsement and continued improvements in software, few studies of good design clearly demonstrate improvement in medical education over traditional modalities(2). Based on its advantages, CAI has been applied to use in teaching in variety of subjects. It is expected that people can access the data and information through CAI conveniently with more details compared to hard copy or textbooks. Those...
who develop software for CAI have the same objective
that CAI can help the learning process more conve-
nient and effective. However, in Thailand, there are
limited data supporting the idea in biomedical sciences
with rather complicated contents and novel for the
new learners.

CAI has been assumed to have an increasing
role in medical education, and becomes increasingly
available. However, evaluation of these programs is
primarily in beginning stages. Previous study reported
that students could learn parasitology from computer-
based instruction as effectively as from traditional
lecture-based instruction, and they could do so in less
time\(^3\). However, no such study is performed in Thai
students. We report here the results of the study using
CAI compared to the hard copy for study of lessons in
parasitology.

**Material and Method**

**Participants**

Total of 60 students attending the third-year
parasitology class at Faculty of Medicine, Chulalong-
korn University, Bangkok, Thailand, were recruited for
this study. All students had never read the lessons we
used for the study before joining this study. The study
was performed at the Computer Center, Faculty of
Medicine, Chulalongkorn University. All participants
were informed about the study as part of the CAI
evaluation.

**Study design**

Two topics of the subject “Parasitology”, *As-
caris lumbricoides*\(^4\) and *Enterobius vermicularis*\(^5\),
were chosen for this study. The CAI format of both
lessons was developed and the hard copies were
printed out from the original files. Therefore, both CAI
and hard copy had the same contents and pictures. We
divided students into 2 groups (30 each) for the cross-
over designed study: the first group used CAI-lesson
for the topic “*A. lumbricoides*” then switched to use
the hard copy lesson for the topic “*E. vermicularis*”,
the second group performed vice versa (Fig. 1). Each
student had one computer to use during the study.
Each group had 30 minutes for each lesson.

**Evaluation of efficiency of CAI**

Efficiency of CAI was assessed by comparing
students’ performances on the 10-multiple choice
question test after each lesson, maximum time allowed
for completion is 10 minutes. We evaluated the outcome
by comparing the score from each test.

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**Evaluation of participants’ satisfaction**

A questionnaire was considered to be the
method to evaluate the students’ satisfaction. The
questionnaire consisted of 3 parts: demographic back-
ground of participants, online learning experience, and
satisfaction with the CAI. The satisfaction with the
CAI comprised 18 items (13 rating scale questions, 2
checklist questions, and 3 open-ended questions). For
each rating scale question, students were asked to
provide a response on a 5 point rating scale from ‘most
disagree’ (1 point) to ‘most agree’ (5 point). We also
provided open-ended questions concerning the
problems students encountered during study with
CAI and hard copy. Students were also asked for the
suggestions that might help improve their study.

**Data collection and analysis**

The data were recorded and analysed by
using Microsoft\(^6\) Excel 2000 version 9.0. Descriptive
statistics were used to analyse the demographic
characteristics and their overall satisfaction. Written
responses from the open-ended questions were
assessed using content analysis.

**Results**

**Characteristics of study population**

Out of 60 students, total of 58 students (26
males and 32 females) finished the study and 55
students returning the completed evaluation forms.
Two students were late and therefore, did not finish
the test in time. Therefore, we excluded from the study.
The average GPAX of the participants was 2.91 \(\pm\) 0.31.

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**Fig. 1** Cross-over design for study of the CAI com-
pared to hard copy lessons
Table 1. The score from multiple choice question test

<table>
<thead>
<tr>
<th>Topic</th>
<th>Ascaris lumbricoides</th>
<th>Enterobius vermicularis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study type</td>
<td>CAI</td>
<td>Hard copy</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>9.03 ± 1.10</td>
<td>8.86 ± 1.21</td>
</tr>
<tr>
<td>Unpaired T-test, p=</td>
<td>0.56</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Interestingly, most students (53%) used less than 5 hours a week for self-study, 33% spent 5-10 hours a week, and 14% spent over 10 hours a week. One-third of the students used computer 1/2 - 2 hours a week and another one-third used 2 - 6 hours a week, about 12% used computer more than 6 hours a week, while the rest used less than 1/2 hour a week. Almost everyone (57 students) used to use Web Browser such as Netscape or Internet Explorer to access Web sites. Surprisingly, only 32% knew what CAI is, and 22% used to use CAI before participating this study.

**Welfare performance of both tests**

The test results for both groups showed that the students could understand the contents of both lessons very well with the score about 90%. However, there was no statistical significant difference when compared study with CAI to hard copy (Table 1). There was no correlation between the sex with the effectiveness of CAI (data not showed).

**Participants’ satisfaction**

We provided the evaluation form asking about participants’ satisfaction and attitude concerning the use of CAI with the rating scale of 1-5 (Table 2). The average score was more than 4 in terms of: easy to use, convenient for searching, less time consuming, understandable, attracting. Participants also did not have much stress while using CAI (score 3.9).

**Suggestions and problems with CAI using**

Concerning the problems the students encountered when using CAI, 24/58 had no comments. Among the problems raised, about 25% of the students had problems of either headache, eye pain, or eye discomfort. Around 25% complained about accessibility of CAI, either no computers at home, computer hang, slow internet/network connection or network errors. Only a few (6.9%) thought that the contents on CAI and the format, as well as pictures would attract their attention.

The most comments concerning using hard copy (32.8%) were boring, not attractive. 17.2% thought that it needed more time to study and search the information. 17.2% felt that it was more difficult to search the specific topic or issue of interest. However, 17.2% comments on wasting of papers when using hard copy, documents might be lost if it was not textbooks. Only 5.2% still thought that it was convenient to carry sheets and could study anytime and anywhere. Only 1 student complained of stress when reading hard copy. 17.2% did not have comments on using hard copy.

Almost all suggestion requested to improve CAI in biomedical sciences, both in quantity and quality. The quality should include content with details, beautiful detailed pictures, narration, and 3-dimensional pictures. The test questions for each topic with answers would be useful for self-study. However, students thought that self-study in some topics would not make them totally understood. Instructors were required to create CAI in many topics in the biomedical sciences.

Table 2. Attitude when using CAI for study

<table>
<thead>
<tr>
<th>Preferable characteristics</th>
<th>Mean*</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI: easy to use</td>
<td>4.352</td>
<td>0.805</td>
</tr>
<tr>
<td>CAI: convenient to search data</td>
<td>4.491</td>
<td>0.635</td>
</tr>
<tr>
<td>CAI: less time consuming</td>
<td>4.527</td>
<td>0.663</td>
</tr>
<tr>
<td>CAI: understandable</td>
<td>4.036</td>
<td>0.719</td>
</tr>
<tr>
<td>CAI: attractive to use</td>
<td>4.436</td>
<td>0.660</td>
</tr>
<tr>
<td>CAI: no stress when using</td>
<td>3.927</td>
<td>1.034</td>
</tr>
</tbody>
</table>

* rating by 5 point scale; 1: most disagree, 2: rather disagree, 3: neutral, 4: rather agree, and 5: most agree

Table 3. Attitude when using CAI compared to hard copy for the study

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean*</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAI: more convenient than hard copy</td>
<td>4.276</td>
<td>0.760</td>
</tr>
<tr>
<td>CAI: less time consuming than hard copy</td>
<td>4.293</td>
<td>0.773</td>
</tr>
<tr>
<td>CAI: more understandable than hard copy</td>
<td>3.466</td>
<td>0.863</td>
</tr>
<tr>
<td>CAI: more attractive to learn than hard copy</td>
<td>4.414</td>
<td>0.650</td>
</tr>
<tr>
<td>CAI: less stressful than hard copy</td>
<td>3.741</td>
<td>1.069</td>
</tr>
<tr>
<td>CAI: more satisfactory than hard copy</td>
<td>3.879</td>
<td>1.077</td>
</tr>
</tbody>
</table>

* rating by 5 point scale; 1: most favor hard copy, 2: rather favor hard copy, 3: neutral, 4: rather favor CAI, and 5: most favor CAI
Discussion

Parasitology is a morphologic science that require visual learning. Students need to develop the ability to identify the parasites. Using a microscope is usually time-consuming, and make it difficult for students to study the morphology of parasites. Therefore, students need to be taught how to learn from CAI materials available to them. Like a laboratory class, it must be fully integrated into a module if real benefits are to be obtained. Therefore, students need to be taught how to learn from CAI materials and how to integrate this learning tool in their learning strategy. Furthermore, teachers need to be supported not only with information about the availability of software but also, equally important, about how it can be integrated into modules. Most importantly, the more comprehensive research how CAI can best be utilized should be done.

Our study confirmed the statement that CAI is useful in education. Therefore, it is recommended to be developed and used widely. Although, the computer experience is correlated with time spent learning and their satisfaction, but we found that it was not correlated to their effectiveness of CAI. The data indicate that CAI is more attractive to be used and students gain benefit comparable to hard copy. However, it did not mean that students would be more successful than learning from hard copy or standard textbooks as showed in other studies. This may due to the fact that the tested students have high potential and ability to learn, therefore, they can learn from any materials provided. Alternately, the questions in the test may be too straightforward, since we limited the time for doing the test after finishing the topics. Therefore, we only asked the knowledge related to the contents provided, not testing the application or other aspects. Of interest is that our study suggested that CAI may not be able to totally replace the hard copy or standard textbooks. The reason is that some students still preferred hard copy to CAI, since they could not rely on only computers which were not always accessible. Some students were also used to reading hard copy, and not used to reading from the computer screen.

Current research suggests that computer-based books are valuable as an alternative educational medium. It is accepted that Medical school faculty members are being asked to assume new academic duties for which they have received no formal training, especially new computer-based instructional programs. In order to succeed at these new teaching tasks, faculty development through attention to the competencies needed by individual teachers, and to the institutional policies required to promote academic excellence.

As some professional schools have replaced microscopes for histology laboratory instruction with printed and electronic media, it is recognized that these media cannot replace experience with the microscope and that there is a cognitive dissonance of completely replacing microscopic study. With a live or taped video demonstration on the first day of each exhibit, the students can easily identify exact field and the label features with little help from an instructor. However, they think that no resource is valued significantly more than the microscope exhibits, but the video demonstrations are valued significantly more than the printed atlas or atlas on CD. The advantages are (1) students’ time is used efficiently, (2) only one slide set and a fourth as many microscopes need to be maintained compared with a traditional laboratory, and (3) one-of-a-kind slides derives from research activities provided for high impact learning. A study on CAI in histology, a morphologic science, shows that students who used at least 2 different CAI programs scored significantly higher on the final examination than those who used only the CAI tool designed by their site’s instructor.

In summary, while genuine materials for study are limited, CAI is useful in subjects related to medical education especially in parasitology, which has complex life cycles with detailed pictures and descriptions appropriate for self-directed learning. Compare with the study from hard copy, students can use CAI to study more details on morphology of the parasites by click on a zoom-in or zoom-out and click on the internal organ to get more information. Most students prefer CAI to the traditional laboratory-lecture format although they feel that teaching by teachers will be more helpful. The well-designed and appropriately used CAI tool may help students achieve the better learning efficiency. Multidisciplinary learning by the sharing
of resources has benefits to students. However, the integration of CAI into teaching programmes needs to be managed to take into account students' reluctance to rely on this method of instruction\(^{(13)}\).

Acknowledgements

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References

โปรแกรมคอมพิวเตอร์ช่วยสอนในวิชาประดิวิทยา: การศึกษาแบบข้ามกลุ่ม

วิวัฒน์ สาระประเสริฐ, พพรัตน์ จรัสสิงห์, อิศรางค์ นุชปั่นฤทธิ์, สุรชัย นุชปั่นฤทธิ์

ผลการเปรียบเทียบการศึกษาบทเรียนในวิชาประดิวิทยาโดยใช้โปรแกรมคอมพิวเตอร์ช่วยสอน กับการใช้เอกสารปกติ โดยทำการศึกษาในนิสิตชั้นปีที่ 3 ที่ศึกษาวิชาประดิวิทยา ของคณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย จำนวน 60 คน ซึ่งได้ทำการจัดกลุ่มแบบสุ่มแบ่งนิสิตออกเป็น 2 กลุ่มๆ ละเท่ากัน (กลุ่มละ 30 คน) บทเรียนที่ได้เลือกมาทดสอบได้แก่ 院院士เพื่อง kul ลำ และพยาธิวิชย์มุด ซึ่งได้จัดเตรียมบทเรียนทั้งใน รูปแบบโปรแกรมคอมพิวเตอร์ช่วยสอนกับการใช้เอกสารปกติ อาศัยการศึกษาแบบข้ามกลุ่ม กลุ่มแรกจะได้รับการสอนบทเรียนโดยการใช้เอกสารปกติ กลุ่มที่ 2 ได้รับการสอนบทเรียนโดยการใช้โปรแกรมคอมพิวเตอร์ช่วยสอน ภายหลังการศึกษาแต่ละบทเรียนเป็นเวลา 30 นาที จะทำการทดสอบโดยใช้คำถามแบบตัวเลือก บทเรียนละ 10 ข้อ ไม่พบความแตกต่างอย่างมีนัยสำคัญระหว่างคะแนนของนิสิตทั้งสองกลุ่ม อย่างไรก็ตาม นิสิตส่วนมากพอใจโปรแกรมคอมพิวเตอร์ช่วยสอนมากกว่าเอกสารปกติ (91.67%) เนื่องจากใช้งานง่าย สะดวก ใช้เวลา่น้อย เข้าใจได้ง่าย ผ่านสื่อ และไม่ลำบากความเครียด ความคิดเห็นเกี่ยวกับการใช้เอกสารปกติได้แก่ เกิดความน่าเบื่อเมื่อใช้เอกสารปกติ (ร้อยละ 32.8) การเกิดความเครียดขณะอ่านเอกสารปกติ (ร้อยละ 2) ลดลงถึงความยาก (ร้อยละ 17.2) การใช้เวลามากในการสืบค้นข้อมูลเพิ่มเติม (ร้อยละ 17.2) และการสืบเสี้ยวกระดาษของการใช้เอกสารปกติ อย่างไรก็ตามนิสิตร้อยละ 58.6 แสดงความเห็นใจกับปัญญาของการใช้โปรแกรมคอมพิวเตอร์ช่วยสอน โดยในกลุ่มนี้ร้อยละ 25 ระบุถึงความไม่สบายทางกาย (เช่น ปวดศีรษะ ปวดตา) ร้อยละ 25 ระบุถึงการเข้าใจได้ยากของโปรแกรมคอมพิวเตอร์ช่วยสอน (เช่น ไม่มีคอมพิวเตอร์ ปัญญาของเครื่องคอมพิวเตอร์ และการเข้าถึงระบบเครื่องข่าย) การศึกษาครั้งนี้แสดงให้เห็นว่าผู้สอนควรสร้างและพัฒนาโปรแกรมคอมพิวเตอร์ช่วยสอนของบทเรียนในวิชาระยะศาสตร์สุขภาพ ทั้งในด้านการเพิ่มปริมาณและคุณภาพ (เช่นรายละเอียดของเนื้อหา รูปภาพ และการบรรยาย)