

GENERIC MODEL OF COMPUTATION FOR INTELLIGENT COMPUTER AIDED PROGRESS ASSESSMENT (ICAP)

Esyin Chew and Norah Jones

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Esyin Chew and Norah Jones

Centre for Excellence in Learning and Teaching (CELT)

University of Glamorgan

Wales

CF37 1DL

echew@glam.ac.uk

njones2@glam.ac.uk

Abstract

One of the major problems levelled at many traditional learning initiatives is that individual progress and performance are not well monitored and evaluated. This paper offers a model of computation for intelligent computer aided progress assessment and reports on a recent study which formulated a generic model (iCAP) from a prototype testing in a 4 months course. A walk through study for the course was carried out which was used to formulate an intelligent computer aided assessment system. As a result, a generalized model was designed which was used to determine the expected performance bank with various levels of difficulty (challenge levels), thereby ensuring that, if the test is randomized, levels of competence could be examined. Each individual result of the student (current performance level) is captured and stored in a progress file for self-reviewing by the student as well as by the lecturer for assessment and monitoring purposes. The benefits and limitations of iCAP are discussed at the end of the paper.

Introduction

One of the criticisms levelled at many traditional learning initiatives is that they are not effectively monitored and evaluated (Thorne, 2003). The importance of effective assessment feedback in student learning is recognised by The National Audit Office in their report "Improving Student Achievement in English Higher Education" (2002) which indicates that the poor quality of academic feedback is a key factor in contributing to student dropout. The Quality Assurance Agency (QAA) code of practice on assessment (2000) also makes clear the need for timely and consistent feedback. The indication that assessment feedback is a concern for students emerged in the results of the National Student Survey (2005) where universities in the UK were consistently rated by their students as being poor in feedback on assessment.

The conventional assessment methods of learners in higher educational institutions are for example, quiz, tests, examinations, assignments or

projects. The student's learning performance is assessed at a certain point in time usually towards the end of a course, as a result the individual's progress is difficult to monitor in the traditional classroom. The lecturer may be aware of each individual's learning progress in a smaller class size but this would be a great challenge when dealing with a large number of students.

In conventional assessment methods, the learner tends to obtain the current state of his or her individual performance in an authoritarian and reactive way, and without a traceable progress history. The pragmatic educationalist, John Dewey's influence has been a leading factor in the abandonment of authoritarian methods and in the growing emphasis upon learning through experimentation and progression (Jay, 2003). The learner's knowledge will grow alongside the self-initiative experimentation in the learning process. It is essential that this progress is fully captured and recorded throughout the course and any learner's performance measures are based on these. Inge (1919, p15) also defined,

... the aim of education is the knowledge not of facts but of values. Values are facts apprehended in their relation to each other, and to ourselves. The wise man is he who knows the relative values of things.

There has been a growing literature on the impact of computers on education but more recently there has been an interest in blended learning. The blended learning environment is designed to aid the learners with state-of-the-art information technology in addition to the traditional face-to-face classroom. It combines face-to-face instruction with computer-mediated instruction (Bonk and Graham, 2006). Blended learning represents a more diverse combining of a variety of approaches such as coaching by a supervisor, participation in an online class and case studies (Jones, 2006). This paper contributes to the literature on blended learning and focuses on feedback and assessment.

This paper presents an intelligent computer aided progress assessment model, namely iCAP, to satisfy the agenda mentioned above. The proposed assessment model which captured and recorded the learner's progress played a part in providing essential values that the learner not only relied on the final marks given in each test or examination but also the satisfaction from the advancement to an improved or more developed state. Moreover, the lecturer could easily trace the learner's progress history to evaluate the achievement of its overall educational aims. The iCAP model is generalised from a system prototype which was tested in a teaching module in a local university. It is able to identify each learner's performance and the progress of improvement or decline.

There are few current systems in the market which have been analysed and evaluated and not many e-learning system have been designed with an inbuilt progress report facility. iCap has been designed to fill this gap. The summary is described in the below table:

Features/Tools	English-at-home.com	E-Classroom	(ITF) Modules	PrimeLearning.com
Progress Report	No	No	Yes	Yes
Teaching Material	Yes	Yes	Yes	Yes
Quiz/Test Module	Yes	Yes	Yes	Yes
System Type	Web-based	Web-based	Web-based	Web-Based
Developed By	English At Home	Mind Leaders	Arizona State University, US	AMA
URL	http://www.english-at-home.com/	http://eclassroom.internettoolkit.com/cgi/signon.exe?text1=demo&text2=demo	http://elearning.asu.edu/ITF_Module/	http://elearn.primelarning.com/prime/PrimeLearnerHomePage.jsp

Table 1.1: Summary Table for Current System Comparison

2.0 Analysis and Design for iCAP

Assessment plays an important part in providing essential information on whether the student is on track as required by the lecturer. If one of the purposes of education is to help close the gap between actual and desired performance we must be able to define what that original level of performance was (Thorne, K., 2003). The expected **performance level (plevel)** may vary from one lecturer to another. However it must be first defined before the assessment process is carried out. In this study, the plevel scale defined by the lecturer who was conducting the course is from level 1 to level 6 and the desired performance level is in level 3.

The scale for **level of challenge (lc)** varies from one lecturer to another. The lecturer defined lc in this research as “easy”, “moderate” and “challenging”. It is important to identify the difficulties of individual question - lc in the questions bank. There are two methods to obtain the lc:

Determined by the lecturer: this method is timelier but subjective because questions which are determined ‘easy’ by the lecturer may be difficult from the learner’s perspective.

Determined by past students: this method is objective but it may be tedious and time consuming to gather the necessary data.

The research is based on method (2) discussed above. 150 questions from lesson one to nine in the course were identified based on the course material. The tests were distributed to 28 students who took the module. It was conducted to determine the lc for all the questions to be placed in the questions banks. Respondents are required to categories the lc for each question as “easy”, “moderate” or “challenging”. The analyses of the

respondents' comments are concluded in Table 2.1. The *lc* of a question is determined by highest votes from the respondents.

Scale Level of Challenges (<i>lc</i>)	Lessons in the Subject		
	Lesson 1-3	Lesson 4-6	Lesson 7-9
Easy	15	16	14
Moderate	22	20	21
Challenge	13	14	15
Total	50	50	50

Table 2.1 Example of the Summary for Questions' Challenges Level (*c*)

All 150 questions were grouped and stored in the database according to the different levels of challenge showed in the table. The number of questions in a test was set by the educator and in this case **15** questions per test are defined. The *plevel* associated with the *lc* is designed in the below table:

Performance Level	Easy	Moderate	Challenge	Total
1	10	5	0	15
2	8	5	2	15
3	6	5	4	15
4	4	5	6	15
5	2	5	8	15
6	0	5	10	15

Table 2.2 Example of the Association for *plevel* and *lc*

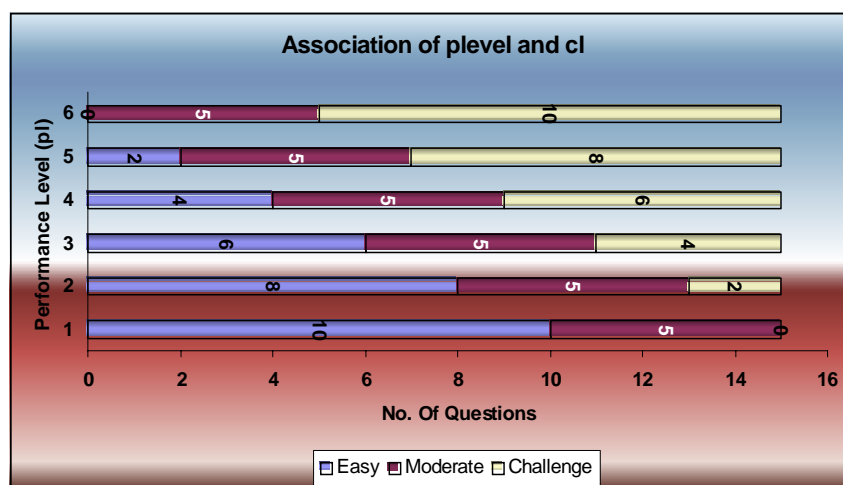


Figure 2.1 Association of *plevel* and *lc*

Figure 2.1 describes a phenomena that the higher the level of challenge (*lc*) is, then fewer the easier questions will be selected. Likewise, the higher the *lc* is, the more challenging questions will be selected.

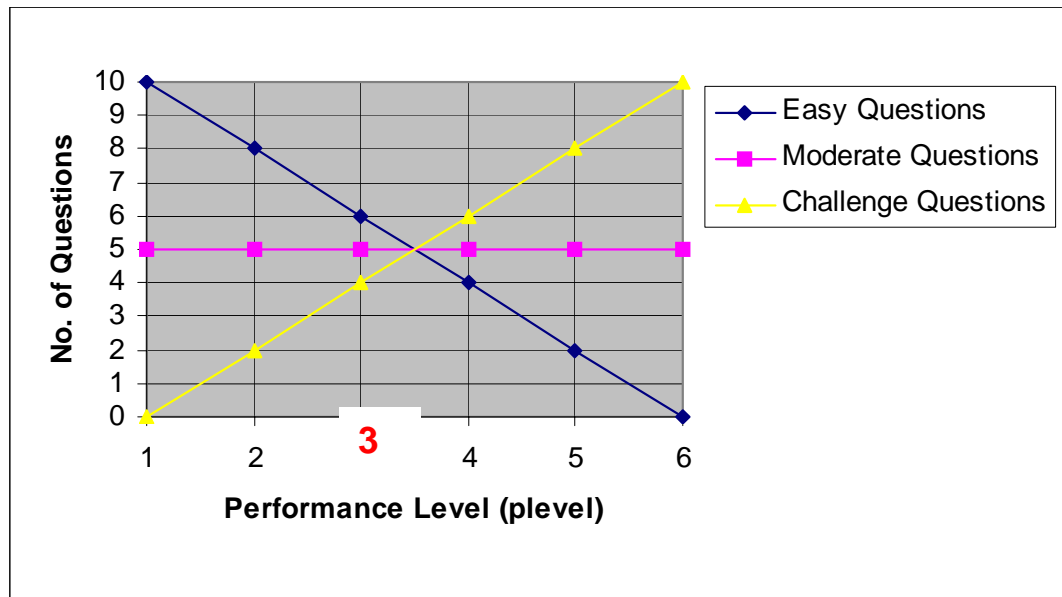


Figure 2.2 Desired Performance Level

Level 3 in Figure 2.2 is the predefined desired performance level. Each learner's default *plevel* was assigned to Level 3 upon their registration for the progress test, which contained 6 easy questions, 5 moderate questions and 4 challenge questions. There is a smaller set of performance level (*pl*) which determined the individual test if required. 60% score was defined as a *pl*. When the learner has completed the test, the level of challenge will automatically be decreased if the learner's result is below the desired performance level. Likewise, the level of challenge will be increased if the learner's result is above the desired performance level. Table 2.3 shows the scale of increase/decrease for *lc* in the study.

Score Range to <i>pl</i> in Each Test	Level of Challenge to be Increased / Decreased
90 - 100	+4
80 - 89	+3
70 - 79	+2
60 - 69	+1
50 - 59	0
40 - 49	-1
30 - 39	-2
20 - 29	-3
0 - 19	-4

Table 2.3 Example of Scale for the Increase/Decrease of *lc*

There will be no changes to the lc if the learner's current score is the same as the desired performance level (pl). For instance if the desired pl is now 50% and a learner's current score of the test is 58%, there will be no increase or decrease to the learner's current lc . Further elaboration is explained in the scenarios detailed below:

A learner is first enrolled in the course and the $plevel$ is defaulted at level 3. The learner only manages to get 45% in the first test, which means that the learner fails the particular test. From table 2.2, the level of challenge is decreased to -1. The level of challenge in the next test will be set to $(3-1) = 2$.

If the same learner passed the second test with 85% score, the level of challenge is increased +3. The level of challenge for next test will be set to $(2+3) = 5$.

The maximum lc is at level 6 and the minimum lc is at level 1. Learners can only be assigned to the maximum or the minimum level even if their result required a level that exceeds the maximum or minimum level. Once the learner's level of challenge reaches the maximum level of 6 there would be no more increases. The same applies to the minimum level. Once the learner's level of challenge reaches the minimum level of 1 there would be no more decreases.

In summary, a set of predefined levels of challenge of test questions are generated randomly from the questions bank aligned with the learners' level of challenge history record. This means that the higher the marks scored by the learner the higher the level of challenge of the questions. In addition the learner's progress is captured and recorded for self-motivation and for the lecturer to monitor. Thus, this facilitates a unique subset of questions to be delivered for each assessment or each learner.

3.0 Generalisation of iCAP

The computation discussed above can be generalised into a generic model for intelligent Computer Aided Progress assessment (iCAP). First, the scale and desired performance level ($plevel$) are defined. The level of challenge (lc) is determined by probability samples (Cohen, Manion and Morrison, 2000) either by representatives of the sample (e.g. the lecturer) or a wider group of sample (e.g. students who has taken the course previously). The number of questions is identified and its relationship with $plevel$ is showed in the below figures.

If y = Number of Questions, $x = plevel$ and $k = lc$, the below graphs explain their basic association and relationship.

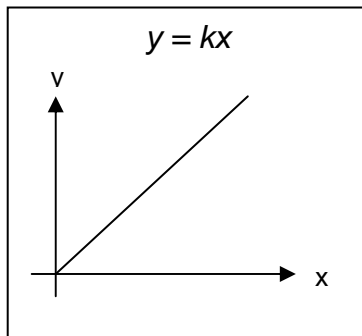


Figure 3.1 Challenge

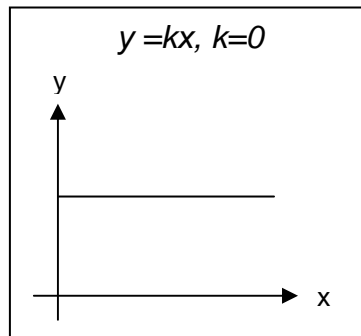


Figure 3.2 Moderate

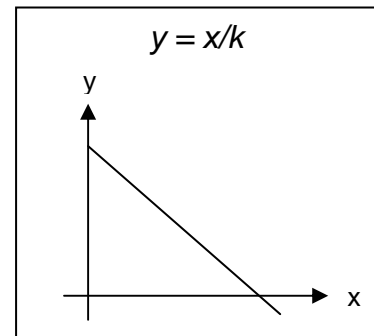


Figure 3.3 Easy

Figure 3.2 shows the default *plevel* or desired *plevel* which can be assigned to all learners when they first enrolled onto the course. Figure 3.1 illustrates the normal learning curve, which means the challenge questions which were selected from the questions bank are increased from level to level. Figure 3.2 shows the constant of the moderate questions when the level of challenge is increasing. Figure 3.3 shows how the easy questions decrease when the level of challenge increases. This simple model is used to formulate the test questions blended with its level of challenge as showed in the Table 2.2. Figure 3.4 depicts that when lc identified is increased or decreased (e.g.: $lc = 5$ {“Very Easy”, “Easy”, “Moderate”, “Challenging”, “Very Challenging”}). The educator can define the lc based on their requirements and preference for students’ assessment. The higher number of lc , the more complex the table of association for *plevel* and lc will be.

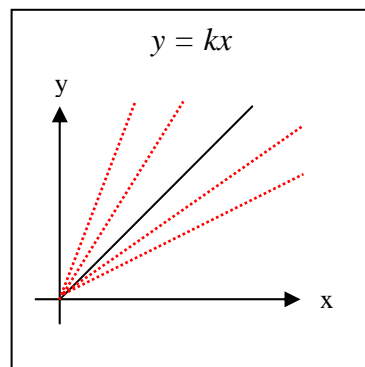


Figure 3.4 $y=kx$

The higher number of *lc*, the more complex the matrix table of association for *plevel* and *lc* will be. Thus, the generic table is:

<i>plevel \ lc</i>	<i>i</i>
<i>j</i>	Qs

Where,

plevel = Performance Level

lc = Level of Challenge

i = Scale value of *lc*, e.g.: easy, moderate and challenge.

j = Sequential value of *plevel*

Qs = Questions Selected

Qs is the number of questions to be selected in each matrix cell of *plevel* and each *lc*. It can be represented in the below computation:

$$(lc_1)_{plevel1} + (lc_2)_{plevel2} + (lc_3)_{plevel3} + \dots (lc_j)_{plevelj}$$

where *i* = 1 to total number of questions and *j* = scale of *lc*

3.1 Possibility for Repeating Question in iCAP

Each test consists of 15 objectives questions with 4 answer options. For each test, the database must consist of at least 50 questions. This is to ensure that the possibility for a single question to be repeated in the second set is lower or equal to 9%.

Possibility for a single question to be repeated in the 2nd set of question:

$$= 15/50 \times 15/50$$

$$= 1/2 \times 1/2$$

$$= 1/4$$

$$= 0.09 \text{ or } 9\%$$

Figure 3.5: Possibility for a Question may be repeated in the 2nd set of Question

Although the possibility for a single question to be repeated in the 2nd set of question is 9%, which may be considered quite high, all the questions in the quiz are randomly arranged. This means that the possibility for a single question to be repeated as the same sequence in the 2nd set of questions is as low as $(1/50)^{15}$.

3.2 Generic Framework for iCAP

The research can be concluded in a generic model showed in Figure 3.6.

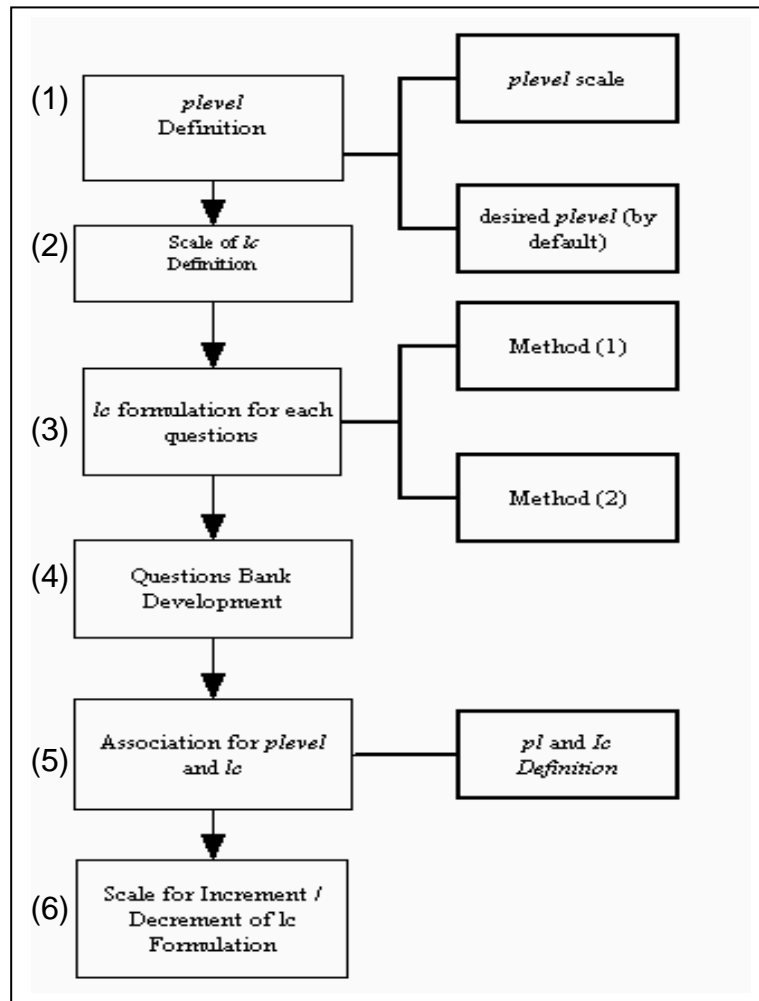


Figure 3.6: Generic Model for iCAP Computation.

3.3 Results and Benefits of iCAP Model in Blended Learning Environment

- **Progress Profile**

Each learner's progress is captured and stored. The learners can always access the individual progress profile to identify their current state of performance versus their desired performance level. The lecturer can easily assess the learner's performance to identify each learner's performance and the progress of improvement or decline. Necessary action can be taken from this point.

- **Expandability and Flexibility**

Expandability and flexibility means that this model is able to be expanded and adapted to a variety of requirements for lecturers. For instance:

(1) The lecturer has the flexibility to determine the desired performance level and the level of challenge for each question.

(2) The lecturer is allowed to add, edit, and delete the questions in the question bank. The lecturer can also change the question difficulty level if necessary.

(3) iCAP can be applied to any content of teaching material.

(4) The lecturer can define the test which falls into the category of learners' tutorials or formal examinations.

- **Intelligent**

Once the computation model is completed, the system developed based on the iCAP design is intelligent and able to generate many sets of test questions aligned to the individual learner's current performance level. The assessments and the learner's progress are captured and stored automatically.

3.4 Limitations of iCAP Model in Blended Learning Environment

- The questions model designed in iCAP has best fit with "Multiple Choices", "Fill in the Blank" or "True or False" type of questions. Essay or short comprehensive questions are difficult to be assessed unless another intelligent essay marking system is embedded with iCAP.
- The process of the model is tedious from the lecturer's perspective especially in stage (3). Although it is upfront effort for the lecturer at this stage, the learners can experience the benefits later.
- The definition of level of challenge can vary from one person to another. An assumption is made in iCAP – based on the majority'.
- Lecturer acceptance is not assured, with many educators doubting the ability of multiple-choice testing to assess higher order skills, and be a fair reflection of a student's knowledge. Many lecturers see multiple-choice as providing the students with the answer, it does not judge their knowledge (Davies, 2002).

4.0 Conclusion

This model is particularly useful for formative assessment where an iterative learning process is desired; learners can test themselves repeatedly on the same subject but with varied questions set to identify their current level of performance to the lecturer's expected performance. It plays a vital role from the lecturer's perspective because much attention is given towards individual learner's progress and the accessibility is wider and more effective.

Key advantages of the iCAP are the appreciation of individual learner's performance by educators and it acts as a motivation for learners to achieve their expected performance.

Future work for iCAP is to design an improved generation of assessments will be designed for computers making full use of essay, audio, video and

advanced graphics to enable complex questions and simulations. Such developments mean that ensuring quality will require a new and sophisticated range of measures from the level of the question to the level of educational management purposes (McKenna, 2000). The next wave of blended learning is 'Education Unplugged'. This represents an evolution of blended learning that leverages the portability and utility of mobile and personal devices (Wagner, E., D., 2006). iCAP can be shifted from a web-based model aligned to the next generation of learning which is more personalised and customised based on the individual learner's and educator's needs.

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Appendix A – Screen Shots of the System Implemented by iCAP model.

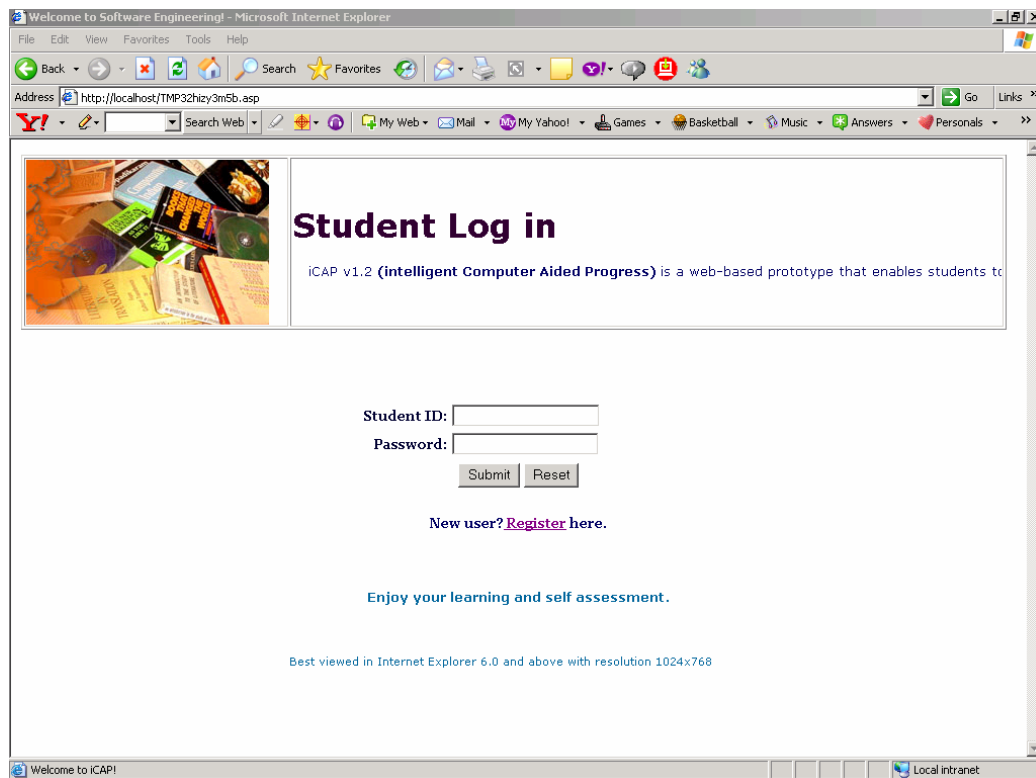



Figure 4.1: Learner's Log in Page



Figure 4.2: Learner's Main Page

Windows taskbar with various icons (back, forward, home, search, etc.) and a Windows logo in the top right corner.

Student Personal Profile



[Back to Student main page](#)

Login Information

Student ID: student001
Student Password: [\(change password\)](#)

Personal Information

First name: student
Last name: student
NRIC: 214456577687
Age: 22
Sex: Male
Email: student@university.ac.uk
Date of Birth: 6, April1982
Address: 21, Address 123, PJ.
[\(Edit Personal Information\)](#)

Students' Progress *

Student's level of difficulty: Level 6
Current level of difficulty: Level 6
Pass Mark: 80%
Quiz passed: 0

**by default user level of difficulty and current level of difficulty is set to be at 'level 3', pass mark is set to be '50%' and quiz passed is '0'*

Quizzes Result :

Quiz 1 result: Not taken
Quiz 2 result: Not taken
Quiz 3 result: Not taken

Figure 4.3: Learner's Progress Profile

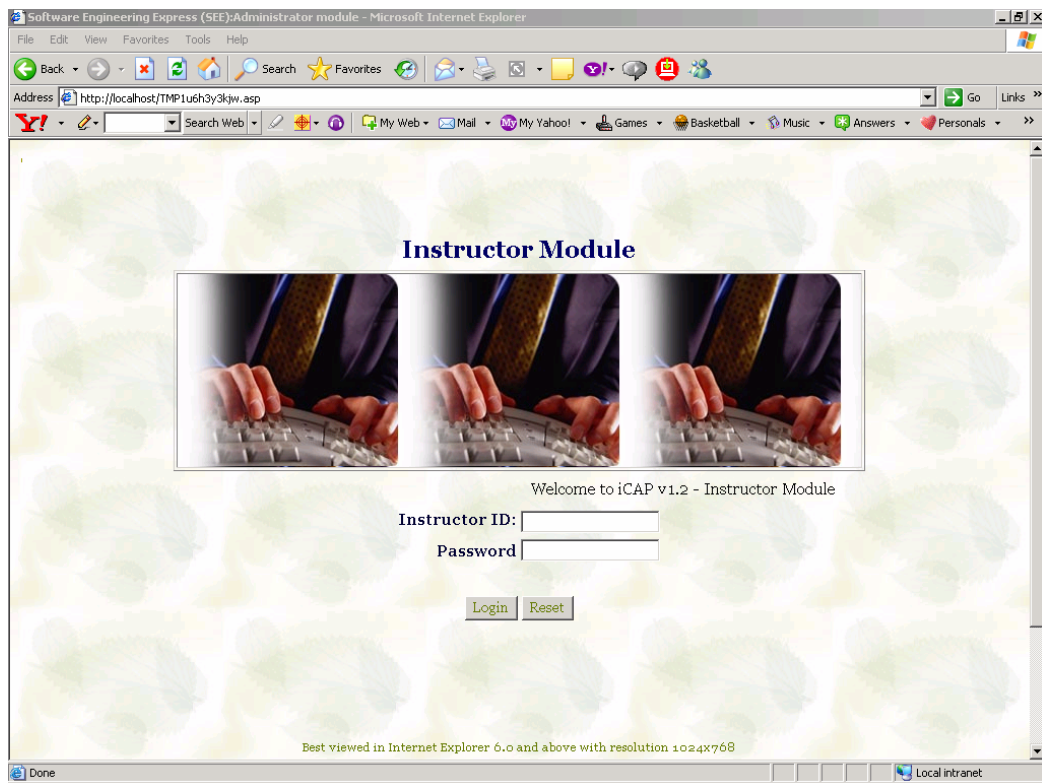


Figure 4.4: Instructor's Log In Page



Figure 4.5: Instructor's Main Page