

# Fostering a Successful Learning Approach to Object-Oriented Programming

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## **Keywords:**

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## **Abstract**

A study learning and object-oriented programming (Hughes and Peiris, 2006a) examined student approaches using ASSIST – the Approaches to Study Skills Inventory for Students (Tait et al., 1998). Findings included a correlation between a surface apathetic approach and poor performance. Subsequently, the authors have worked to answer the common question “*How can we support those students having difficulty learning object-oriented programming*”. The premise taken in this project is that students identified as having a tendency towards a surface apathetic approach could be counselled with respect to their approach to learning, i.e. to advise them about adopt alternative activities and strategies that would better support successful learning about Java programming. The work of the project was to develop an automated system to identify learning approaches taken and to provide subsequent advice. A key aspect of the project was to make a system that would be privately and independently usable by students from object-oriented programming classes across the wider CS community. The solution adopted was a web site with the ASSIST questionnaire linked to a wiki page (advice from students successfully adopting a deep approach) or to an exemplars page (advice for students adopting a surface approach).

## **Aims**

The project aimed to:

- (i) develop in students an appreciation that a surface apathetic approach to learning should be avoided, in order to improve the likelihood of success in object-oriented programming;
- (ii) promote the use of different activities that correspond to deep learning in object-oriented programming.

## **Outcomes**

A web site has been developed to provide students with a profile of their current approach to learning, and a resource to help them improve the quality and efficiency of their learning (<http://www.computing.dundee.ac.uk/projects/learn/wikiasp>). Data has been gathered locally and from further afield, as a result of promotion of the project at two conferences. Preliminary data has been analysed. Further data will be gathered after the project is promoted at the project workshop in February 2007, to

better accumulate data to sign-off the final outcome, i.e. a profile of approaches to learning object-oriented programming of students across the UK.

The project has attracted interest from two overseas institutions to date (America and Turkey), and students from these institutions have been invited to participate in the project in 2007.

### **Deliverables**

Three public resources have been produced:

1. a web site that:
  - (a) analyses student responses to the ASSIST questionnaire to provide a summary of the student's current approach to learning;
  - (b) provides a wiki-style catalogue of activities relevant to a deep approach to learning object oriented programming;
  - (c) gathers feedback regarding the process.
2. a conference paper (Hughes and Peiris, 2006a)
3. one poster (Hughes and Peiris, 2006b)

Two further deliverables have been produced for HEA-ICS:

4. project final report
5. project additional report (this document)

### **Background**

A perennial problem in computer science education is how to manage those students experiencing significant difficulties learning to program. Two components of this problem are: (i) identifying those students likely to have such difficulties at a sufficiently early stage to intervene, and (ii) designing an intervention that will support those students to overcome their challenges. These two issues are related: identification of the 'challenged' students requires an understanding of the underlying problems that they face. Only when such students have been identified can a recovery programme be instigated to address the problem.

A number of studies have attempted to identify factors contributing to success or failure in computer science studies, in order to identify members of the challenged cohort. Factors considered include: demographic profiles (Rountree et al., 2002), mathematics capability (Boyle et al., 2002), entry qualifications (Alexander et al., 2003), prior experience of programming (Morrison and Newman, 2001, Ventura, 2005), and self-efficacy and expectations of success (Ramalingam and Wiedenbeck, 1998). When the focus of attention moved towards object-oriented programming, investigations were again made of mathematics experience and prior programming experience (but with conflicting results (Alexander et al., 2003, Bergin and Reilly, 2005), and the attributes of the students, such as academic ability, gender, and background (Ventura, 2005, Wilson, 2002). Despite many years of such research, neither a predictor of a "failure factor" nor aptitude has been demonstrated convincingly. Nevertheless, the importance of identifying the deficits of ineffective novices is regularly noted (Rountree et al., 2002).

More recently, attention moved towards students' attitudes to learning (Ramalingam and Wiedenbeck, 1998). Research into student learning has stimulated interest in their approach to study, habits, strategies, and skills (Allert, 2004). Associations between learning styles and learning approaches and levels of achievement have been found across a range of disciplines, e.g., (Byrne et al., 2004, Murphy and Tyler, 2005). Learning styles are considered to be intrinsic behaviors habitually applied by learners. Learning approaches describe tendencies: they are not immutable, nor are they independent of learning circumstance or environment. Nonetheless it is believed that "*students also seem to develop habits in studying which may lead them to rely more on one or other approach*" (Entwistle, 1996). Learning styles have been considered with respect to computer science students (Chamillard and Sward, 2005), but learning approaches have been given less attention.

An earlier investigation by the authors (Hughes and Peiris, 2006a) related to the identification of students with difficulties, using quantitative data about the approaches students adopted whilst learning object-oriented programming. The measure of learning approach used was the Approaches to Study Skills Inventory for Students – ASSIST (Tait et al., 1998). This inventory of study strategies confirmed three main dimensions related to studying – (i) a deep approach, which has orientations towards meaning; (ii) a surface apathetic approach, which features memorizing and reproducing; and (iii) a strategic approach, which focuses upon achievement. A deep approach is one where the intention is to understand and relate ideas, and where evidence is considered. In contrast a surface apathetic approach is one where the intention is to cope with course requirements. A surface apathetic approach to studying can be ineffective, focusing upon memorizing but with a lack of purpose, and syllabus-bound. The strategic approach is adopted to achieve the highest possible grades, and includes considered time management, organized studying, and alertness to assessment demands.

This project aimed to develop system to automate delivery of ASSIST and the learning approaches assessment. Subsequent information would depend upon the assessment identified for each participant, i.e. advice about further learning, or an opportunity to share those successful approaches taken. Use of a web site for this would permit students from any number of institutions to have independent and private access, and allow repeated visits.

## **Putting it into Practice**

The following sections summarise the main stages of the project development.

### **1. User-centred design**

A design brief was given to two research assistants supporting the project with the following design targets:

- a. W3C consortium accessibility;
- b. 'cool' appearance stimulating to typical student population;
- c. succinctness to encourage completion of questionnaire;
- d. conformance with legal and ethical responsibilities.

Two alternative web site designs were created. One design was "conventional", using pastel colours and a standard font. The alternative design used a computer analogy and "technical" font to frame the questions appropriately for computing students. The

designs were evaluated over three occasions with mixed-gender student groups. Evaluations solicited comment about usability, performance, and motivating effect of the two designs, and desirable properties of such a web site and its embedded questionnaire. Replicated comments were used to confirm the preferred choice of web site design, and to derive drivers for the revisions of the www site. Comments provided related to typeface, font, colours, spacing, clarity of wording, text alignment, graphics, answer spaces, titles, and visual feedback. The web site then was revised to account for recommendations thereby obtained.

## **2. Functionality: ASSIST**

An intranet version of the ASSIST questionnaire was reconfigured to be suitable for incorporation in the web site. The revised questionnaire was embedded in the web site, and tested to confirm compatibility with a number of standard web browsers.

## **3. Functionality: receive advice or be an adviser**

A catalogue of deep learning activities performed during object-oriented programming was created, and partially populated with activities identified from a sample of the student and staff population. Investigation was made of published deep learning activities associated with object-oriented programming, and the web catalogue further populated with example suggestions.

A wiki component site was developed to gather student descriptions of deep learning activities for learning java, and incorporated into the web site.

The web site was revised so that participants who demonstrated primarily:

- a) a “deep” or “strategic” learning approach were linked to the wiki, and requested to input *their* approach to learning object-oriented learning;
- b) a “surface” learning approach were advised about their approach, and linked to the exemplars page.

All participants were requested to provide their feedback about the process.

## **4. Functionality: administration**

Administrative pages were added to the web site to provide:

- a mechanism for the administrator to add examples to the exemplars page;
- monitoring of changes made to the site;
- quantitative analysis of the proportions of different approaches taken;
- collection and presentation of statistics on access and usage;
- viewing of feedback provided.

## **5. Publicising the project**

The project was publicised during a paper presentation at the 11<sup>th</sup> Annual Conference on Innovation and Technology in Computer Science Education, in Bologna. Academics from Bilkent University, Turkey, and University of California, San Diego, stated their wish to have their students use the web site the following year. These universities have since been invited to access the web site and contribute to the wiki. A poster summarising the project was created and presented at the HEA-ICS conference in Dublin.

Agreement was reached with HEA-ICS for organisation of a Dundee-hosted workshop in February 2007 to publicise the project and recruit further participants.

Workshop details were publicised at the HEA-ICS conference, and a number of academics expressed an interest in participating. Postcards advertising the workshop were taken by a number of people. These postcards have been distributed to a number of institutions since then, both overseas and in the U.K.

## **6. Analysis data**

Analysis of data was made after the HEA-ICS conference, and after a further cohort of University of Dundee students were invited to contribute. Preliminary quantitative and qualitative evaluation was made of data gathered at that point. The main conclusion drawn at this point is that the majority of students completing the ASSIST questionnaire are taking either a deep or a strategic approach when learning about object-oriented programming. Of the 60 most recent data sets, only 8% of students have taken a predominantly surface-oriented approach. 45% of students have taken a deep approach, and 45% have taken a strategic approach.

## **7. Security: wiki attack**

In late November, an attack was made upon the wiki. A number of pages were defaced. Defacing pages were removed and spammed pages were reverted to their previous good state. Following project team discussions, it was decided not to take immediate action, to determine if the attack was a one-off incident. Later in the same month, further attacks were made upon the wiki. The IP addresses of the attackers were apparently from random IPs, e.g.

85.255.113.380  
62.96.223.210  
219.77.211.194  
200.24.5.106  
66.11.50.71  
125.16.48.74

In some cases, pages were overwritten with apparent gibberish. In other cases, text was changed to point to advertising sites *apparently* promoting foreign exchange, airline tickets, or furniture, but actually advertising various products (e.g. via pharmacynetonline) unrelated to computer science education or learning! Malicious edits were removed, and pages again returned to their original state.

The project team again discussed options that could be taken to prevent further vandalising of the wiki. The preferred option was to leave the wiki as open as possible, but to monitor the site for unwelcome revisions. A utility written by one of the project team, research assistant Thomas Nind, was adopted to detect further changes to the wiki. The utility, called “Simplifier”, hides the Windows interface (Start menu, desktop etc.) and leaves just one text box at the top left hand corner in which the project team can enter commands. The URL of the project wiki is added as a site to be watched. A popup appears showing the HTML of the page, and the person monitoring a page can select some of the HTML to watch. “Simplifier” checks the page every 60 seconds and looks for the highlighted HTML: if there is not an exact match then it pops up an alert box. Use of this utility has since allowed the project team to monitor the site, and to remove spam entries to the wiki.

## **Issues and Debates**

A number of main issues have been identified that other institutions may wish to bear in mind if considering joining the project, or copying any aspect of its methodology.

### Will students make use of a web-based questionnaire?

Only a small amount of data has been gathered: voluntary contributions by students are occasional, and despite the usability of the web site, it has gathered less data than hard copy versions of the ASSIST questionnaire were presented, face-to-face, to students. However, the majority of student contributions are to be from deep- or surface-learners (in terms of object-oriented programming), i.e. those students in least need of additional support. The most important user group is the surface-learning student set. It is the opinion of the project team that if *any* of that user group is helped by the project then it will have been successful.

### Will students contribute to a wiki?

If popularity and value is judged by the number of visits to a web page, then the wiki is the most popular aspect of the site. However this may be due to unexpected activity (see section 7 above) that is unrelated to the project. Wikis are becoming very common, and no student expressed reluctance to contribute.

### Is a user-centred design approach appropriate?

Most feedback received was about the user interface, with a number of strong opinions being written about the choice of font and colour scheme. Comments from participants known to be from the upper-end of the age scale were less complimentary than those from younger participants. This may be a reflection of the membership of the evaluation groups, all of whom were under 25 year of age.

### What are the problems of using a wiki?

The main problem faced by the team was the set of wiki attacks late in 2006. Wiki spam is becoming an increasing problem for educationalists wishing to use wikis in support of group work and collaboration. Five approaches to this problem have been identified:-

1. accept the problem, but regularly monitor the site and immediately cleanse it upon detection of spam
2. contain the problem, by configuring the wiki to block out any revisions from sites with given IP addresses or address ranges from spam blacklists
3. contain the problem, by running a wiki anti-spam tool (a list of candidate tools can be found at <http://www.wikimatrix.org/forum/viewtopic.php?id=244>)
4. avoid the problem, by locking down the site so that only members with authorised passwords can log on to edit, and only administrators can add pages
5. avoid the problem, by using a wiki alternative such as a VLE-based system that only members of approved higher education institutions can access. An example is Blackboard's Teams Site: it provides an interactive and collaborative area that individuals or groups can add text, links, or graphics to.

In this case, the solution adopted was the first, using a tool authored by one of the project team to identify problems. Options 2 and 3 are not believed to be very effective if a wiki is subject to a sustained attack, particularly where the attackers use different and changing IP addresses. Options 4 and 5 prevent the wiki from acting as an open collaborative tool, and would prevent the wiki genuinely being used across the UK.

## Resources

### HEA-ICS Development Fund resources

1. <http://www.computing.dundee.ac.uk/projects/learn/wikiasp> - the Learn web site that incorporates:-
  - the ASSIST questionnaire (<http://www.computing.dundee.ac.uk/projects/learn/questionnaire/Questionnaire.php>)
  - the wiki for students' comments (<http://www.computing.dundee.ac.uk/projects/learn/wikiasp/wiki.asp>)
  - exemplars (<http://www.computing.dundee.ac.uk/projects/learn/wikiasp/exemplar.php>)
  - feedback comments (<http://www.computing.dundee.ac.uk/projects/learn/wikiasp/feedback.php>)
  - an admin link that provides for transfer of content from the wiki to exemplars, and gathers site statistics (information available upon request).
2. Conference report (Hughes and Peiris, 2006a)
3. Conference poster (Hughes and Peiris, 2006b)

### Text books

RICHARDSON, W. (2006) *Blogs, Wikis, Podcasts, and Other Powerful Web Tools for Classrooms*, Sage Publications Inc (USA).

### Web pages

A comparison of Wikis

<http://www.wikimatrix.org/compare/WikiASP+MediaWiki+TikiWiki+TracWiki>

What is WikiSpam?

<http://c2.com/cgi/wiki?WikiSpam>

What is a WikiWikiWeb?

<http://c2.com/cgi/wiki?WikiWikiWeb>

WikiAsp (recommended software)

*"Wiki Asp is a wiki server written in ASP (Active Server Pages) code for Microsoft Windows. It is a derivative of the original Aspwiki engine. It is probably one of the easiest to use and most effective wiki programs available for FREE. The Wiki Asp program code was written and is now being maintained by Elrey Ronald" - see*

<http://www28.brinkster.com/lambda326/wiki.asp>

WikiIndex

<http://www.wikiindex.com/Welcome>

Wiki Anti-Spam tools

<http://www.wikimatrix.org/forum/viewtopic.php?id=244>

Wikis in Education

<http://www.wikiineducation.com/display/ikiw/Home>

## Bibliography

- [1] ALEXANDER, S., AMILLO, J., CLARK, M., DANIELS, M., LAXER, C., LOOSE, K. & SHINNERS-KENNEDY, D. (2003) Case Studies in Admissions to and Early Performance in Computer Science Degrees. *ACM SIGCSE Bulletin*, 35, 137-147.
- [2] ALLERT, J. D. (2004) The Effectiveness of Innovative Approaches to CS1: Comparing Opinion to Outcome. *Twenty Sixth Australian Computer Science Conference*. Dunedin, N.Z.
- [3] BERGIN, S. & REILLY, R. (2005) Programming: Factors That Influence Success. *ACM SIGCSE Bulletin*, 37, 411-415.
- [4] BOYLE, R., CARTER, J. & CLARK, M. (2002) What makes them succeed? Entry, progression and graduation in Computer Science. *Journal of Further & Higher Education*, 26, 3-18.
- [5] BYRNE, M., FLOOD, B. & WILLIS, P. (2004) Using the Student Learning Framework to Explore the Variation in Academic Performance of European Business Students. *Journal of Further and Higher Education*, 28, 67-78.
- [6] CHAMILLARD, A. & SWARD, R. E. (2005) Learning Styles across the Curriculum. *Tenth Annual Conference on Innovation and Technology in Computer Science Education*. Monte de Caparica, Portugal.
- [7] ENTWISTLE, N. (1996) Supporting Effective Learning: a research perspective. Edinburgh, Centre for Learning and Instruction, University of Edinburgh.
- [8] HUGHES, J. & PEIRIS, D. R. (2006a) ASSISTing CS1 students to learn: learning approaches and object-oriented programming. *11th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education*. Bologna, ACM Press.
- [9] HUGHES, J. & PEIRIS, D. R. (2006b) Fostering a successful learning approach to object - oriented programming. *The Higher Education Academy Information and Computer Sciences*. Dublin, The Higher Education Academy Information and Computer Sciences.
- [10] MORRISON, M. & NEWMAN, T. (2001) A Study of the Impact of Student Background and Preparedness on Outcomes in CS1. *Thirty-second SIGCSE Technical Symposium on Computer Science Education*. Charlotte, NC.
- [11] MURPHY, S. M. & TYLER, S. (2005) The Relationship between Learning Approaches to Part-Time Study of Management Courses and Transfer of Learning to the Workplace. *Educational Psychology*, 25, 455-469.
- [12] RAMALINGAM, V. & WIEDENBECK, S. (1998) Development and Validation of Scores on a Computer Programming Self-Efficacy Scale and Group Analyses of Novice Programmer Self-Efficacy. *Journal of Educational Computing Research*, 19, 367-381.
- [13] RICHARDSON, W. (2006) *Blogs, Wikis, Podcasts, and Other Powerful Web Tools for Classrooms*, Sage Publications Inc (USA).
- [14] ROUNTREE, N., ROUNTREE, J. & ROBINS, A. (2002) Predictors of Success and Failure in a CS1 Course. *ACM SIGCSE Bulletin*, 34, 121-124.
- [15] TAIT, H., MCCUNE, V. & ENTWISTLE, N. (1998) ASSIST: a reconceptualization of the Approaches to Studying Inventory. In *Improving Student Learning: Improving Students as Learners*. IN RUST, C. (Ed.) *Improving Student Learning: Improving Students as Learners*. Oxford, The Oxford Centre for Staff & Learning Development.
- [16] VENTURA, P. (2005) Identifying Predictors of Success for an Objects-First CS1. *Computer Science Education*, 15, 223-243.
- [17] WILSON, B. (2002) A Study of Factors Promoting Success in Computer Science including Gender Differences. *Computer Science Education*, 12, 141-164.