The Application of Second Natural Language Acquisition Pedagogy to the teaching of Programming Languages - A Research Agenda

Stephanie A. Robertson & Martin P. Lee
Computing Information Systems Management Group
School of Defence Management
Royal Military College of Science
Cranfield University
Shrivenham, Wiltshire, SN6 8LA, UK.

Abstract

The writing of programs is one of the central activities in computer science education, yet frequently it is poorly taught. In this paper we argue that some of the most recent principles emerging from research into and the successful teaching of second natural languages might be applied to the teaching of programming languages.

The paper begins by reviewing the historical development of the teaching of both second natural languages and programming languages. It continues with a manifesto for potential research areas, in order to test these ideas further.

Introduction

Second natural language teaching has been subjected to a number of pendulum swings in the last few decades largely following the fads and fashions of the education world in general. However, during the last twenty years there has been a significant shift in teaching methods with the emphasis moving away from concentration on grammatical form, to a greater attention on communicative process. (Hymes 1972)

This has resulted ultimately in a "freeing-up" of the language syllabus from rote learning, reciting and translating to the study and understanding of language in use within a cultural framework. It has also brought about a multi-level approach to the teaching and assessment of second languages. Students are no longer expected to be fully conversant with all the structural aspects of a second language but rather are encouraged to communicate in it successfully at various stages, where each stage forms the basis for practical application and assessment.

The ascendancy of linguistics as a subject in its own right has been largely responsible for this change in perspective and attitude. Linguistics is much more than the learning of foreign languages, it is essentially the study of language in use, combined with aspects of psychology, sociology, cross-cultural comparison, language change and of course language structure. It is a vast field of knowledge which has produced a plethora of theoretical and practical research studies which have largely been conducted in the United Kingdom and the United States of America.

It is the results from this research which has led to the massive re-structuring of syllabi and assessment procedures. As a consequence the long-held, traditional values of grammatical accuracy in both the written and spoken word have assumed a much lesser importance. However, these more recent developments need to be seen against a wider backdrop. In order to make relevant comparisons with current practice in teaching computer programming languages, we have drawn together some of the major influences in second language pedagogy over the last 100 years or so.

Historical Development

There have been different strands in the development of second natural language teaching depending on the country of

origin of the language and the institutions responsible within that individual country. However, there are some common features and therefore overriding influences which can be traced.

The last decades of the 19th century witnessed a determined effort in many countries of the western world to:

a. bring modern foreign languages into the school and university curriculum on their own terms

b. emancipate modern languages increasingly from comparison with classical languages

c. reform methods of language teaching in a decisive way.

The reform movement led to the creation of commercial ventures such as Berlitz Language Centres, saw the beginning of important associations of language teachers and professional bodies and more importantly initiated intensive debate on language teaching which has gone on ever since.

After the first World War many countries strongly supported the teaching of second languages in an effort to promote greater international understanding. This is reflected for example in the British report **Modern Studies** (1918) which was a review of language teaching at school and university. Many other initiatives were taken to improve teaching through practical and realistic methods. However, Bloomfield (1942) wrote of this period:

"Our schools and colleges teach us very little about language, and what little they teach is largely in error. The textbooks are far from perfect and some teachers have not sufficient command of the foreign language. Often enough the student, after two, three or four years of instruction, cannot really use the language he has been studying."

Notwithstanding, it was during this period that the first serious attempts were made to resolve language teaching problems by research, for example studies were made into vocabulary selection and testing methods.

The decade of World War II constituted a time of huge development. American wartime language programmes, initiated between 1941 and 1943 were of significant importance. The USA changed the approach to language teaching in a radical way. Through the Armed Forces foreign language training programmes, the Americans claimed that languages could be taught to much larger populations of ordinary learners, i.e. servicemen, more quickly than had previously thought possible through intensive training with an emphasis on the development of oral skills. Although the experience in the USA may not have had the direct influence that is sometimes claimed, elsewhere many teaching methods were re-examined in the light of it.

In the post-war era many countries in the world became aware of language learning problems because of the increase in language diversity. Several languages were recognised as world languages and gained official status in the UN and UNESCO. In order to improve communication on an international scale, more languages needed to be learned as second languages by more people to aid in this cross-cultural exchange. This was made possible by the increase in education for all, because it meant that language learning lost its elitist status.

A further post-war phenomenon was an increasing intellectual awareness of and an interest in the scientific study of language problems. The rapid growth of linguistics as an independent discipline and the study of language from the point of view of other disciplines such as psychology and sociology gained in importance throughout the 50s and 60s.

During this time renewed efforts were made to improve second language learning. They included:

- the use of technology - tape-recorders, labs, tv
- new organisational patterns - immersion, intensive courses
- methodological innovations - audio-visual/audio-lingual

- development of innovative materials/programmes
- specialist teacher education schemes
- a new research emphasis

However these new methods did not produce spectacular results. Flaws were found in the linguistic and psychological principles which had been put forward.

The upheaval in linguistics and psycholinguistics created by Noam Chomsky's transformational generative grammar coupled with his debate with B F Skinner the behavioral psychologist, had begun to affect language pedagogy by the mid 60s. But it was not until the 70s and 80s that there was a shift away from a concern with teaching methods to one with language teaching objectives, language content and curriculum design. A number of applied linguists, namely Candlin, Widdowson and Wilkins experimented with some new ideas derived mainly from discourse analysis, speech act theory and language as interaction. This development was brought about as a backlash against the "drilling" techniques of the previous era. There was a search for a deeper understanding of the nature of the second language learning process itself, and much of this research was conducted in several North American universities.

The key concept which triggered this new approach was that of communicative competence, a term first coined by Hymes (1972) in his seminal paper. It reflects the social nature of language and is in direct contrast to Chomsky's notion of linguistic competence. It has led to the idea of communicative language teaching as a central focus. Further research into second language pedagogy has been carried out in the late 80s early 90s with an emphasis on language as social interaction, in the following areas:

- sociolinguistics
- use of authentic materials
- cultural milieu of language being studied
- effectiveness of error correction
- first language to help hypothesis test
- influence of affective factors - age, gender, motivation
- concept of readiness - sequence of learning
- concept of interlanguage

There is a long history in the development of second language pedagogy since the study of language is at the core of any curriculum. This is not so for the study of programming languages and possibly explains why there is a continuing dilemma over what to teach and how. Nevertheless it is important to investigate the historical developments such as they are, so that meaningful comparisons may be made for future research and development in pedagogical theory.

Programming Language Teaching

So far this paper has looked at second natural language theories of learning and teaching rather than programming languages. Unfortunately programming has traditionally been taught with little reference to natural language pedagogy. In particular it has concentrated on the writing of code rather than the reading of existing code (Crosby & Stelovsky, 1990). Little use has been made of pre-written or partly-written software. Instead teachers have concentrated on keywords and language structures. This is a bottom-up approach of isolated, 'programming-in-the-small' without tool support.

Some work has been done on the links between natural language ability and programming skills, e.g. Deimel & Moffat 1982. They conclude:

"The possibility should not be overlooked that our teaching methods can be modified to take better advantage of existing linguistic competence. In particular, a course utilizing reading of programs to gain syntactic, semantic, and pragmatic insights into programming might well be able to capitalize on reading skills of students and better

prepare them to write programs. In fact, the ability to read programs and the relation of that ability to other linguistic and programming skills is, we believe, an important area for future research".

Over a decade later this is still a conclusion with which we concur.

This is all to be expected given the relative youth of programming language teaching compared with natural language tuition.

This paper advocates research into the teaching of literary techniques such as the use of dictionaries, thesauri, manuals, software catalogues and handbooks. In particular the use of chunking, such as the use of stock phrases and programming clichés (e.g. Schank et alia 1993), needs further research.

More attention needs to be paid to comprehension (Crosby & Stelovsky, 1990) and vocabulary (Shaw, 1989). Style, which has received some interest (Thomas & Oman, 1990), requires more investigation, as does the importance of teaching naming (Carroll, 1982).

A further area of potential interest is that of the use of analogy and metaphor in programming teaching.

Conclusions

Bearing in mind the results of this small survey into the development of second language pedagogical theory and its equivalent in terms of the teaching of programming languages, it would appear that it might be fruitful to carry out some research into the following areas:

- the value of reading programs before writing
- the use of authentic programs
- the influence of affective factors - age, gender etc.
- the study of the cultural milieu of programs
- the concept of readiness
- the possibility of an interlanguage
- the use of English to help hypothesis testing

Acknowledgements

This paper is published with the permission of the Principal of the Royal Military College of Science. This work arose out of an undergraduate project (Ellis, 1992).

Bibliography and References

Bloomfield, L. (1942) "Outline guide for the practical study of foreign languages" Special publication of the Linguistics Society of America, Baltimore.

Canale, M. & Swain, M. (1980) "Theoretical bases of communicative approaches to second language teaching and testing" Applied Linguistics, 1, 1-47.

Carroll, J. M. (1982) "Creative names for personal files in an interactive computing environment" Int. J. Man-Machine Studies, 16, 405-438.

Celce-Murcia, M. (1985) (ed.) "Beyond basics - issues and research" TESOL, Newbury House.

Chomsky, N. (1980) "Rules and Representations" The Behavioral & Brain Sciences, 3.

Crosby, M. E. & Stelovsky, J. (1990) "How do we read algorithms? A case study" IEEE Computer, 23, 1, 24-35.

Deimel, L. E. & Moffat, D. V. (1982) "More on natural language and programming skills" Communications of the A.C.M., 25, 7, 501.

Ellis, T. (1992) "English language tuition in teaching programming" Unpublished BSc dissertation, Royal Military College of Science.

Second Language Continued On Page 20

[29] A. J. Turner. A summary of the ACM/IEEE-CS joint curriculum task force report: Computing curricula 1991. *CACM*, 34(6):69–84, Jun 1991.

[30] J. F. Čigas. The art of state. In M. J. Mansfield, C. M. White, and J. Hartman, editors, *23rd Computer science education*, pages 153–156, Kansas, Missouri, Mar 1992. ACM SIGCSE bulletin, 24(1).

[31] R. L. Wainwright. Introducing functional programming in discrete mathematics. In M. J. Mansfield, C. M. White, and J. Hartman, editors, *23rd Computer science education*, pages 147–152, Kansas, Missouri, Mar 1992. ACM SIGCSE bulletin, 24(1).

[32] S. Wiedenbeck. Learning recursion as a concept and as a programming technique. In H. L. Dersham, editor, *19th Computer science education*, pages 275–278, Atlanta, Georgia, Feb 1988. ACM SIGCSE bulletin, 20(1).

**************************Second Language Continued From Page 12**************************

Hymes, D. (1972) "On Communicative Competence" in "Sociolinguistics, Selected Readings", Pride & Holmes (eds.)

Krashen, S et al (1977) "Age, rate and eventual attainment in second language acquisition" TESOL Quarterly, 13, 4, 573-582.

Ledgard, H., Whiteside, J. A., Singer, A. & Seymour, W. (1980) "The natural language of interactive systems" Communications of the A.C.M., 23, 10, 556-563.

Lee, M. P., Peacock, D. & Jeffreys, S. (1989) "dBASE as a first programming language" Collegiate Microcomputer, VII, 2, 111-116.

Lee, M. P., Harrison, A. & Kent, A. E. (1991) "Group projects for the software engineering of knowledge based systems" pp 95-107 IN King, G. A. (ed.) "Software engineering in higher education" Southampton Institute, 1-874011-00-1.

Lee, M. P., Pryce, J.D. & Harrison, A. (1994) "Prolog as a first programming language" pp 275-281 IN King, G. A. et alia (eds.) "Software engineering in higher education" Computational Mechnics Publications, 1-85312-289-0.

Peacock, D., Ralhan, V. K., Jeffreys, S. & Lee, M. P. (1988) "The use of a structured project to teach program development" ACM SIGCSE Bulletin, 19, 4, 10-18.

Peacock, D., Ralhan, V. K. & Lee, M. P. (1988) "A first year course in software design and use" ACM SIGCSE Bulletin, 20, 4, 2-8.

Schank, P. K., Linn, M. C. & Clancy, M. J. (1993) "Supporting Pascal programming with an on-line template library and case studies" Int. J. Man-Machine Studies, 38, 1031-1048.

Shaw, Guise & Reddy (1989) "What a software engineer needs to know: program vocabulary" Software Engineering Institute Technical Report 30, Carnegie-Mellon University, Pittsburgh.

Stern, H. H., (1986) "Fundamental Concepts of Language Teaching" OUP.

Thomas, E. J. & Oman, P. W. (1990) "A bibliography of programming style" ACM SIGPLAN Notices, 25, 2, 7-16.