Learning Styles in Distance Education Students Learning to Program.

Kit Logan and Pete Thomas
Department of Computing
Open University, UK
{K.Logan,P.G.Thomas}@open.ac.uk

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Abstract

This paper reports on an experiment looking at differences in students' learning style preferences and the relationship with observed work related practices and recent findings from the ongoing research. Three questionnaires to measure learning and cognitive style preferences; Honey & Mumford, Grasha and Reichmann and an English translation of Antonietti's questionnaire on visual and verbal strategies (QSVV) were made available and distributed via the web in electronic format to 60 volunteers prior to their taking the Open University's distance learning course M206 "An Object Orientated Approach". An additional questionnaire gathering demographic information, perceived level of comfort with computing and other related measures was also published electronically. A significant gender difference was found on the Honey & Mumford measures of pragmatism and theorist, with significant difference between genders and from published normal values. The Grasha–Reichmann scales showed no differences between genders but the sample studied had higher than expected scores on both the independent and collaborative scales compared to published norms. Further investigation resolved the possible presence of two types of student, an independent type and a collaborative/participant type.

Introduction

Comprehensive reviews of cognitive psychology research indicate that people exhibit significant individual differences in how they approach solving problems and undertake other similar decision-making activities. (Robertson 1985; Zenhausern 1990; Gordon 1998)However, there is debate over the permanence and actual nature of these differences which are often classified as cognitive styles, learning styles and/or learning strategies. In addition, the teacher's and/or course designer's own individual preferences for the type and way they deliver material needs to be taken into consideration as both the instructor's as well as the learner's individual learning style differences/preferences can influence the effectiveness of pedagogical material, delivery and methods. (Griggs 1991a; Griggs 1991b; Renniger *et al.* 1992; Wilson 1996; Warren and Dziuban 1997; Montgomery and Grout 1998; Lang *et al.* 1999; Goold and Rimmer 2000)A simple example being individuals who have a strong visual memory but weaker verbal processing will find text based material harder to process than individuals who have stronger verbal skills. In the traditional classroom environment a teacher has the chance to adapt or explain material to suit individuals' needs, but in distance education where a teacher is frequently not present, pedagogical material is more uniformly presented with much less opportunity to optimise material to an individual's needs.

This study investigates the preferred learning styles of distance education students learning to program as part of an ongoing series of studies using AESOP, An Electronic Student Observatory Project.

AESOP

AESOP, An Electronic Student Observatory Project, (Thomas *et al.* 1998a; Thomas *et al.* 1998b; MacGregor *et al.* 1999; Logan 2000; Thomas and Paine 2000b; Thomas and Paine 2000a; Logan and Thomas 2001)is a series of studies observing groups of distance education students as they study the

Open University's computing course M206: An Object Orientated Approach. It comprises of a collection of tools that allow remote observation of student's online behaviour as they work through the computer based practical work of a course designed to teach the concepts of object orientated programming using an adapted LearningWorks Smalltalk programming language. (Goldberg *et al.*; Open University; Ingalls 1981)Delivery of the material is mainly via paper based chapters and Learning Books (LB's) - online computer based practical work that follows each chapter, but also includes tuition via conferencing systems and televised programs in association with the British Broadcasting Company. Further information about AESOP can be found at www.open.ac.uk/aesop.

Cognitive and Learning Styles

The topics of cognitive and learning styles cover very broad areas that are too exhaustive to cover in detail. The intention is to introduce these concepts, provide a synopsis of current understanding in the area and review in greater detail those cognitive and learning styles that are of specific relevance to the present research.

Cognitive Styles

Historically, the construct of cognitive style is frequently cited as having been proposed originally by Allport (Allport 1937) with a more contemporary exploration of individual differences provided by Bruner *et al*. (Bruner *et al.* 1956). Most studies in the area of cognitive style developed from an interest in individual differences in the 1960's and 1970's during which time a number of cognitive styles and associated inventories were developed (Messick and associates 1976; Smith 1984).

There is no clear definition of what the cognitive style construct is. As well as finding the term 'cognitive style' being described using a number of different concepts, the same concepts have also been called by different names in the literature instead of cognitive style adding to the confusion such as *cognitive preferences* (Tamir and Cohen 1980)and *cognitive strategies* as noted by Messick. (Messick and associates 1976)

The expression *cognitive ability* is another term often used, (Robertson 1985; Leutner and Plass 1998; Virvou and Tsiriga 2000) but refers to the closely related concept of an individual's skill or capacity in a specific cognitive function or cognitive functions generally.

However, in general cognitive styles can be best thought of as referring to an individual's preferred way of perceiving, remembering, thinking and problem solving, involving cognitive functions such as memory, (Baddeley 1992) visual and verbal processing, (Richardson 1977; Antonietti and Baldo 1994; Antonietti and Colombo 1997; Lang *et al.* 1999) field independence - field dependence (Witkin *et al.* 1974; Witkin 1979) or holist - analytic (Riding and Cheema 1991).

Another view taken here in common with research cited by Graham and Liu (Graham 1997; Liu and Ginther 1999) is that cognitive styles *can* change over time, but the actual picture would appear to be more complicated with some styles being more mutable than others. That is, the mutability of a cognitive style is dependent on several factors including dependence on cognitive capacity in that area and on situation specifics that influence how individuals choose to process the information.

Learning Styles

Learning styles are very closely related to cognitive styles and the two terms are often used interchangeably. However, learning styles are probably best regarded as an extension to cognitive styles to distinguish the act of learning from simple processing of information. This view is taken by Riding and Cheema (Riding and Cheema 1991) who noted that those researching learning styles took cognitive style into consideration, but were more interested in the practical, educational applications, while the term cognitive style was reserved for theoretical, academic descriptions. A further differentiation is noted by Liu and Ginther (Liu and Ginther 1999) observing that cognitive styles tended to be associated with bipolar dimensions (a single dimension with two extremes) whereas learning styles in general are usually are associated with several dimensions or scales.

A comprehensive definition for learning styles that has been adopted by leading theorists in the field is given by Keefe (1989) (quoted by Griggs, 1991),

> *"Composite of characteristic cognitive, affective and psychological factors that serve as relatively stable indicators of how a learner perceives, interacts with and responds to the learning environment."*
>
> Keefe (1989)

The important points to draw from this definition is that learning styles reflect an individual's preferences and choices in a learning situation and encompass a range of factors that includes cognitive styles.

However as Griggs (Griggs 1991b) points out, it is important to recognise that learning styles are not related to intelligence, mental ability or actual learning performance and that no learning style can be said to be better than another. That is the best learning style for any individual is specific to the individual and dependent on that individual's cognitive abilities and the learning situation they are in.

Assessment of Cognitive & Learning Styles

Learning and cognitive styles have generated a significant amount of interest because of the influence they can have on the effectiveness of delivery of teaching and pedagogical materials for an individual (Griggs 1991a; Renniger *et al.* 1992; Wilson 1996; Warren and Dziuban 1997; Montgomery and Grout 1998; Lang *et al.* 1999; Goold and Rimmer 2000). Individual differences are also of particular interest to providers of distance education where there is usually no teacher readily available to explain, adapt or tailor the material to an individual's needs should this be necessary.

Assessment of cognitive and learning styles is important for two main reasons. One is to provide a reliable and valid way of being able to compare one individual against another. The second reason is simply because as is the case with cognitive styles, individuals are frequently unaware of their own learning style preferences and therefore the type of learning material that is best for them.

At present the most used and convenient way to assess learning styles is through self-evaluation questionnaires. These provide researchers as well as educators and trainers an easy, reliable and validated way to distribute and assess individual requirements (Cronbach 1990).

Details of questionnaires used in study.

As well as the AESOP software, four questionnaires were used to provide additional information. A general demographic questionnaire (GDQ) designed for distribution using the internet and used in previous AESOP studies providing in addition to necessary contact and general demographic information such as age and gender, questions collecting information about the hardware and software configurations of participants computers and questions relating to their current knowledge, usage and comfort with various computing related tasks.

The remaining three questionnaires collected information on various learning styles: Honey & Mumford's Learning Styles Questionnaire, (Honey 1986; Honey and Mumford 1995) a modified version of the Grasha-Reichmann Learning Styles General Class Form (Grasha 1996) and an English translation of Antonietti & Giorgetti's Questionnaire on Visual and Verbal cognitive style (QSVV) (Antonietti and Giorgetti 1993). All Questionnaires were adapted for distribution via the internet.

The Learning Style Questionnaire, Honey and Mumford

Stages in the simplified Kolb's learning cycle	Associated Learning Style	
	Style	Brief description of style.

Stage 1	Having an experience.	*Activist*	What's new? I'm game for anything
Stage 2	Reviewing an experience.	*Reflector*	I'd like time to think about this.
Stage 3	Concluding from an experience.	*Theorist*	How does this relate to that?
Stage 4	Planning the next steps.	*Pragmatist*	How can I apply this in practice?

Table 1 Summary of Honey & Mumford's Learnings Styles and their association with a simplified version of Kolb's learning cycle (Honey 1991)

The Learning Style Questionnaire (LSQ), Honey and Mumford (Honey 1986; Mumford 1991; Honey and Mumford 1995) is based on a simplified version of Kolb's 1984 cyclical model of the process of learning and used here to help identify one aspect of students' individual preferences for the way they learn. The LSQ is an 80 item self-evaluation inventory, requiring only a positive or negative response to each question. Scores obtained are ranked in relation to their percentiles according to either the general norms from a sample of 3,500 or if desired against norms according to occupational group or gender. In addition and more inline with current views about learning styles the authors assume from the start that the four styles they define: *Activist, Reflector, Theorist* and *Pragmatist*, are each independent of each other and dynamically capable of changing and being changed. Each of the four learning styles is directly related to a stage in the learning cycle and a person's score for each style indicates their strength or weakness at that point in the cycle (Table 1).

Grasha & Reichmann's Student Learning Styles Scales (GRSLSS)

Grasha & Reichmann's Student Learning Styles Scales (Grasha 1996) focuses more on students' preferences for the learning environment. It identifies 6 different styles; *Independent, Avoidant, Collaborative, Dependent, Competitive* and *Participant* (Table 2)

Style	Description of Style
Competitive	Students who learn material in order to perform better than the others in the class. Believe they must compete with other students in a course for the rewards that are offered. Like to be the centre for attention and to receive recognition for their accomplishments in class.
Collaborative	Typical of students who feel they can learn by sharing ideas and talents. They co-operate with the teacher and like to work with others.
Avoidant	Not enthusiastic about learning content and attending class. Do not participate with students and teachers in classroom. They are uninterested and overwhelmed by what goes on in class.
Participant	Good citizens in class. Enjoy going to class and take part in as much of the course activities as possible. Typically eager to do as much of the required and optional course requirements as they can.
Dependent	Show little intellectual curiosity and who learn only what is required. View teacher and peers as sources of structure and support and look to authority figures for specific guidelines on what to do.
Independent	Students who like to think for themselves and are

	confident in their learning abilities. Prefer to learn the content that they feel is important and would prefer to work alone on course projects than with other students.

Table 2. Grasha & Reichmann's Student Learning Styles (Grasha 1996)

The questionnaire is a 60 item self-evaluation inventory scored using a 5-point Likert scale, with the average score for each style ranked according to its percentile position in comparison with the general norm, however only 3 levels of preference (low, moderate and high) are identified for each style. It exists in two forms differing only by the phrasing of the questions; the General Class Form and a Specific Class Form. The Specific Class Form designed for use following a specific lesson and the General Class Form phrased to look at general preferences across all classes/lessons. Both use the same general norms. For the purposes of this study the General Class Form was used.

The questionnaire however was presented in a slightly shortened form by not including the Competitive style scale as a review of the individual questions involved led to an opinion that it's inclusion was not strictly necessary and could be off-putting to students.

Questionnaire on Visual and Verbal Styles (QSVV)

Because of the amount of computer based practical work and visual content involved, a questionnaire was sought to measure the visual and verbal preferences of students taking part in the study. Antonietti and Giorgetti's Questionnaire on Visual and Verbal Styles (QSVV) (Antonietti and Giorgetti 1993) was selected after a review of the literature as it was short consisting of only 18 items and measured visual and verbal cognitive preferences on separate dimensions rather than regard them as both part of the same uni-dimensional scale. The QSVV was however developed and published in Italian and although an English translation of the questionnaire was obtained and used, there is currently no normative data for subjects whose native language is English limiting the level of comparison that can be made. There may also be language specific issues in the use of the English translation of the QSVV.

Method

Students from the 2001 cohort of the Open University's computing course *M206: An Object Orientated Approach* were invited to take part in the study through a message posted on the course's web based notice board. This directed those interested, by hyperlink, to the demographic questionnaire. Students choosing to take part by completing and submitting this questionnaire were subsequently directed to the location of the three online learning style questionnaires and the AESOP recording tool software for downloading. Both the software and learning style questionnaires were made available via the Open University's own First Class email conferencing system which all students are given access to and through a webpage accessible from the AESOP project's website.

Support to help with any student queries about the software or questionnaires while the research was in progress was provided through a central point of contact and a sub-conference set up on the First Class conference.

Students were initially contacted via the notice board at the end of January when the M206 course commenced (The Open University academic year runs from February to September). All students who completed the pre-study were contacted again in late July with a request to email in any recordings they had and to complete the set of four questionnaires again. This was done to optimise the opportunity for returning recordings during a time when many may be away for several weeks and to avoid conflict with exams later in September.

Results

66 students (females N=26, males N=40) responded and completed the pre-study questionnaire. Of these 46 (females N=21, males N=25) continued onto download and complete the learning styles questionnaires. Responses to the questionnaires were compared for demographic differences such as age and gender, both within the group and where possible against the general norms. Significant differences were found in the following measures.

In the Honey and Mumford's Learning Style Questionnaire, significant gender related differences were found in the Pragmatist and Theorist measures. Both the females and males were noted to have distributions skewed from the expected norms, but in opposite directions. Males were significantly less pragmatic both in comparison with the expected normal distribution ($p < 0.01$) and in relation to females. While females were significantly more pragmatic than the expected normal distribution ($p < 0.01$) (Figure 1).

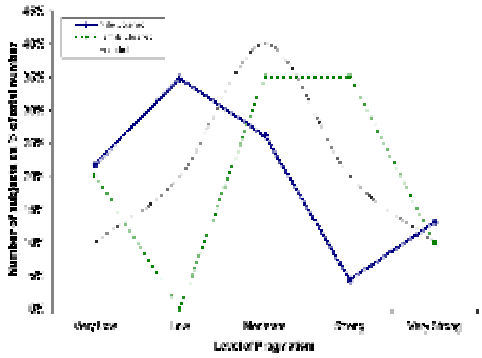

Figure 1. Frequency distribution of preferences on the Pragmatist scale

Of interest is the slight sine wave appearance of both distributions caused by the apparent presence of a small sub-group in each gender displaying the opposite preference to the majority of the group. Unfortunately there is not enough cases to determine whether this is just an artefact, but significant positive correlations were found existing between the Pragmatist, Theorist and Reflector styles for females (Table 3) while males were found to have significant negative correlations between the Activist and the Reflector and Theorist styles (Table 4).

Pearson Corr Sig (2 tailed)	**Theorist**	**Pragmatist**	**Reflector**
Theorist		*.616* .004	*.630* .003
Pragmatist	*.616* .004		*.585* Not sig.
Reflector	*.630* .003	*.585* Not sig	

Table 3 Correlations between Honey & Mumford learning styles in the female subset (n=20)

Pearson Corr Sig (2 tailed)	**Activist**	**Reflector**	**Theorist**
Activist		*-.401* .047	*-.402* .047
Reflector	*-.401* .047		*.280* Not sig.
Theorist	*-.402* .047	*.280* Not sig.	

Table 4 Correlations between Honey & Mumford learning styles in the male subset (n=25)

Gender differences were also found with regard to the Theorist learning style (Figure 2). However, instead of skewed distributions towards a strong or low preference for the style, males had a significantly smaller variance about the norm than the expected normal distribution ($p < 0.05$) while females had a significantly greater variance than the expected normal distribution ($p < 0.05$). The statistical significance of the differences in distributions between the genders is $p < 0.001$.

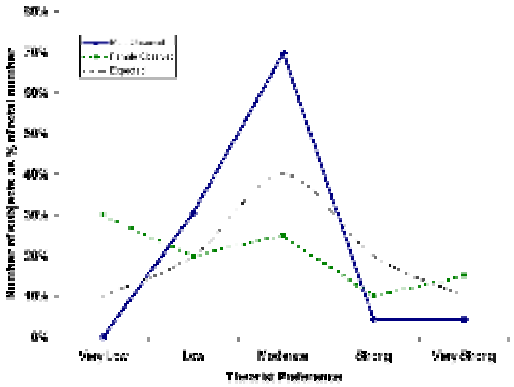

Figure 2. Frequency distribution of preferences for Theorist style

Analysis of the responses to the Grasha-Reichmann Student Learning Styles Scales showed no apparent differences between genders. All scales were found to be significantly different from their expected distributions ($p < 0.01$) (Figure 3). Subjects were also noted to have a greater preference for the collaborative and independent styles than expected.

Significant correlations were also found between Independent and Dependent as well as between Participant and the Avoidant, Collaborative and Dependent scales as viewed in (Table 5).

Pearson Corr Sig. (2-tailed)	**Independent**	**Avoidant**	**Collaborative**	**Dependent**	**Participant**
Independent		*.021* .890	*-.156* .302	*-.310* .036	*.082* .589
Avoidant	*.021* .890		*-.228* .128	*.096* .527	*-.469* .001
Collaborative	*-.156*	*-.228*		*.224*	*.605*

	.302	.128		.135	.000
Dependent	*-.310*	*.096*	*.224*		*.322*
	.036	.527	.135		.029
Participant	*.082*	*-.469*	*.605*	*.322*	
	.589	.001	.000	.029	

Table 5 Correlation matrix of the Grasha-Reichmann Learning Styles

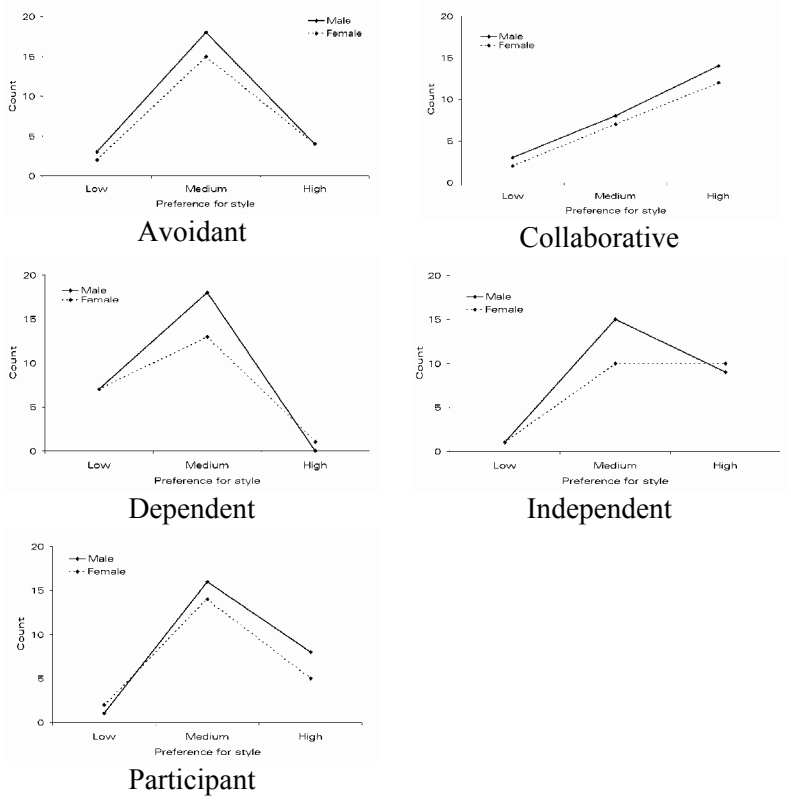

Figure 3. Frequency of preference for Grasha-Reichmann learning styles by gender

No gender or other differences were found with either the visual or verbal scales on the QSVV.

Discussion

The results obtained from the data via questionnaires at the start of the course indicate that there are some definite differences and preferences both between genders and the group as a whole for the various learning styles scales, even within the small subset of subjects who took part in the study.

Gender differences were found only in Honey & Mumford's Learning Styles on the Pragmatist and Theorist measures.

Females were shown to have a greater preference for the pragmatist scale, which corresponds to Stage 4 of Kolb's Learning Cycle, while males had a low preference. However Honey & Mumford (1986) also comment on number of things that inhibit people from being more of a pragmatist which include: A preference for perfect (rather than practical) solutions to problems, seeing even useful techniques as oversimplifications or gimmicks, enjoying interesting diversions (and being side-tracked), leaving things open-ended rather than committing to specific action, believing that someone else's ideas will not work in your situation.

This would seem to indicate that the majority of females taking the M206 computing course are more practically minded and likely to look at how they can apply information learnt while males are less practically minded. In the next phase of the project we intend to investigate whether it may be that

some of these traits are observable in the records of students as they work through the online course material.

Gender differences were also found with the Theorist style but as a significant difference in variation or spread about the mean rather than a shift in preference. Virtually all males had a moderate (n=64%) or low (n= 28%) preference for the Theorist style, while females had a more varied distribution in comparison to the expected norm. It is uncertain as to what the implications of this finding is except that females taking the M206 computing course are far more varied in the theorist learning style than males, who in comparison tend to be neither weak or strong in the theorist style.

Of interest are the correlations found between the various Honey and Mumford learning styles. For females, strong positive correlations exist between the Reflector, Theorist and Pragmatist scales while males had a weaker but still significant negative correlation between the Activist and Reflector styles and also between Activist and Theorist, although there was not a corresponding positive relationship between Reflector and Theorist styles.

The implications from this are that females subjects taking the M206 course can be categorised into two main groups, i.e. those that have strong learning styles on the last three stages of Kolb's cycle or are weak in these three stages. This could be categorised more simply into strong learners and weak learners. Male preferences are harder to unravel, but at its simplest the implication from data is that male subjects taking the M206 course and game for trying new things (Activist) are not so good at taking time to think about things (Reflector) or concluding from an experience (Theorist).

The results from the Grasha-Reichmann Student Learning Styles Scales imply another two types of student taking part, one type with a preference for learning Independently and the other with a preference for Collaborative/Participant learning (suggested by the strong positive correlation between the Collaborative and Participant styles). Support for the presence of these two general types of learner is not strong, but is suggested by skewed distribution preferences for both the Collaborative and Independent styles but a concurrent lack of positive correlation between them which indicates neither are related. Additional, but weak support is also provided by the presence of a small but significant positive correlation between Participant and Dependent styles and a negative correlation between Dependent and Independent scales.

Conclusion

There are a number of implications from the findings of this research. Students who take the distance learning M206 computing course appear to be divided between two different types of learner; those who are generally collaborative and participant, and those who are independent. This would suggest that the way the M206 course is presented and in a wider context the way other online computing courses are presented, requires both opportunities for students to collaborate (such as forums) and to work by themselves in order to meet the needs of the two types of students.

From the Honey and Mumford learning styles data, despite the significant gender differences neither males or females appear to be particularly strong in the Theorist style (concluding from experience), which perhaps indicates that this is an area courses could help improve through their design. However these measures are from early on in the course and would need to be compared again with measures taken later on in course in a repeated measures design to see if there are changes over time and whether these can be attributable to the course.

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