

Technical Report No: 2001/05

*Observations of Study Time Behaviour
Comparisons of 1998 data & 2000 data*

Carina Paine, Pete Thomas

2001

*Department of Computing
Faculty of Mathematics and Computing
The Open University
Walton Hall,
Milton Keynes
MK7 6AA
United Kingdom*

<http://computing.open.ac.uk>



Observations of Study Time Behaviour - Comparison of 1998 data & 2000 data

Introduction

AESOP (An Electronic Student Observatory Project) is a set of computer based data collection tools for recording, replaying and analysing user actions in LearningWorks, a Smalltalk programming environment. A description of the AESOP project can be found in Thomas *et al.* 1998, and descriptions of AESOP's software components can be found in Thomas, 1998 and Macgregor *et al.* 1999.

AESOP observes students studying the Open University course M206 *Computing: An Object-Oriented Approach*. M206 involves students carrying out practical work using Smalltalk in the LearningWorks environment (Woodman *et al.* 1999) (Goldberg *et al.* 1997). Each LearningBook contains a set of interrelated 'Practicals', which are intended to comprise a student 'Session'. Each LearningBook can contain several Sessions.

For each LearningBook that a student works with, the AESOP Recorder records a series of events each with a time and date stamp. The AESOP Analyser includes a number of time tools.

The Analysers time tools will be briefly introduced here. Further details of the tools can be found in Thomas & Paine, 1999 and Thomas & Paine, 2000.

- *The Total Time Tool* calculates the total time spent in a LearningBook by a single student.
- *The All Total Times Tool* is a generalisation of the Total Time Tool that enables us to calculate total times for all students in a given LearningBook.
- *The Session Times Tool* calculates the time spent on each 'Session' in a LearningBook by a student.
- *The All Session Times Tool*¹ is a generalisation of the Session Times Tool that enables us to calculate the time spent on each 'Session' for all students in a given LearningBook.

Since the AESOP Recorder is non-intrusive, there is no information in a recording which explicitly states why a long gap between two events has occurred. Therefore, the time tools have been designed with a *time difference parameter* that allows a user specify the minimum size of a gap above which is to be considered a break in student activity. That is, time that the student is considered *not* to be interacting with a LearningBook.

Terms introduced in Thomas and Paine (1999) to be defined here:

- *Elapsed study time* is the time between the student first opening a LearningBook and the final time the student closes a LearningBook (i.e. no account of breaks is taken). Clearly, the time between closing and re-opening a LearningBook includes time that the student is not interacting with the LearningBook. This time can be subtracted using the time difference parameter to give the *Calculated study time*.
- *Calculated study time* is the time a student spends is considered to spent working with a LearningBook i.e. the user can define the size of a study break and estimate the actual total study time of a LearningBook.

Thomas & Paine (1999) examine various aspects of student behaviour primarily in relation to the time taken, and a selection of results from the data collected are presented. The data for [6] was collected during an initial trial in 1998 involving 20 students, and focused on 7 of the 25 available LearningBooks. From this data a number of conclusions were reached.

¹ This tool is an addition to the 1998 tools

Since this initial trial the AESOP Recorder and Analyser have been refined for massive data collection². In 2000 data was collected from 200 students studying 22 of the course LearningBooks. This provided approximately 2000 recordings to analyse. The findings of these analyses will be discussed here with relation to the previous paper conclusions.

The following conclusions from Thomas and Paine (1999) will be discussed:

- LearningBooks are studied over several days (the average is 3 days)
- A time difference between events of more than 10 minutes represents a break in study
- The amount of time spent on a LearningBook varies considerably between students
- The amount of (calculated) study time is substantially different from the time recommended by the course team (on average, students spend 58% of recommended time)
- In general, students tend to try the first session and then either give up or complete the whole LearningBook.

LearningBooks are studied over several days (average is 3 days)

The 1998 data stated that the elapsed time for a LearningBook showed that, in general, students work through a LearningBook over a significant period of time, often several days (the average was 3 days).

Table 1 shows the data for 2000. From Table 1 it can be seen that LearningBooks are studied over several days. The average is around 10 days, the mode is around 6 days.

² Whilst modifying the AESOP Analysers Tools for massive data collection the output from the tools has changed to allow easy exportation to Microsoft Excel.

Learning Book	No. of Students	Minimum Elapsed Time	Maximum Elapsed Time	Average Elapsed Time
1	22	12s	28d 8m 12s	3d 8h 57m 10s
5	119	25s	94d 18h 59m 44s	2d 14h 4m 31s
6	134	15m 41s	60d 23h 31m 59s	5d 11h 41m 31s
8	150	24s	74d 19h 23m 16s	9d 20h 41m 20s
9	129	3m 33s	49d 21h 51m 24s	7d 18h 47m 16s
10	133	21m 22s	46d 19h 21m 14s	5d 15h 18m 15s
12	114	1m 30s	32d 7h 17m 22s	5d 22h 24m 10s
13	121	33m 38s	45d 20h 31m 18s	5d 15h 37m 2s
14	118	1m 27s	55d 20h 11m 16s	5d 20h 21m 13s
15	109	28m 45s	57d 1h 26m 24s	6d 22h 16m 40s
16	105	41m 5s	127d 32s	11d 15h 40m
17	76	54s	47d 3h 24m 48s	6d 3h 17s
19	75	1m 38s	103d 22h 37m 14s	5d 20h 9m 9s
20	79	1h 19m 40s	64d 15h 59m 29s	14d 7h 28m 2s
21	77	27m 36s	56d 0h 17m 54s	10d 2h 0m 41s
23	59	1h 34m 15s	45d 6h 8m	11d 23h 37m 7s
24	54	22m 25s	45d 3h 52m 57s	6d 6h 15m 23s
26	54	31m 45s	109d 19h 45m 45s	24d 16h 31m 10s
27	53	8m 7s	54d 1h 34m 31s	6d 18h 46m 15s
29	48	32m 37s	77d 16h 21m 13s	28d 5h 31m 42s
31	32	6m 16s	63d 55m 10s	14d 12h 36m 26s
39	27	19h 24m 32s	56d 19h 32m 54s	19d 17h 51m 28s

Table 1 The range and average elapsed time to study a LearningBook

A time difference between events of more than 10 minutes represents a break in study.

The 1998 data showed the results of removing gaps of different sizes from typical student recordings of the same LearningBook. This data indicated that, as the time difference parameter is reduced, the time remaining appeared to converge to a value that can be taken to be a good estimate of the time actually spent by a student actively interacting with the LearningBook. The Total Time Tool and the All Total Times Tool were used to examine the behaviour of students over a number of LearningBooks. From the data it was concluded that a time difference of 10 minutes yielded the most consistent view of what constitutes a break in study.

The All Total Times tool was used to analyse the 2000 data. Almost 2000 student recordings were examined, over a number of LearningBooks. The data confirmed that as the time difference parameter is reduced the time remaining converges to a value and that a time difference of 10 minutes yields the most consistent view of what constitutes a break in study. Table 2 shows a sample of students times for LearningBook 09 as an illustration. Further studies of this effect are still being undertaken.

Student	Total Time Taken						
	When 'Time Difference' is set to:						
	No Break	2 hours	1 hour	30 mins	15 mins	10 mins	5 mins
1	33d 2h 40m 49s	3h 3m 59s	3h 3m 59s	2h 21m 24s	2h 5m 4s	1h 51m 10s	1h 51m 10s
2	99d 23h 8m 21s	1h 52m 13s	1h 52m 13s	1h 52m 13s	1h 52m 13s	1h 52m 13s	1h 39m 20s
3	9h 44m 31s	5h 16m 56s	3h 50m 27s	2h 27m 33s	2h 5m 44s	2h 5m 44s	1h 58m 30s
4	4d 1h 1m 1s	2h 34m 49s	2h 34m 49s	2h 34m 49s	2h 11m 12s	2h 11m 12s	2h 11m 12s
5	72d 6h 57m 12s	3h 30m 09s	2h 23m 22s	1h 50m 26s	1h 50m 26s	1h 50m 26s	1h 50m 26s

Table 2 The calculated study time for a student in LearningBook09 with varying lengths of study break

All data reported in this document will use a time difference parameter of 10 minutes unless stated otherwise. Using a 10 minute parameter will make comparisons with further analyses conducted in 1998 more valid.

The amount of time spent on a LearningBook varies considerably between students.

In the 1998 data The All Total Times tool showed that the amount of time spent in a LearningBook varied considerably between students. This was supported when the data was analysed using the Session Times tool.

Table 3 shows the range of time spent in a LearningBook for the 2000 data. From Table 3 it can be seen that, perhaps not surprisingly, the amount of time spent in a LearningBook varies considerably between students and again this was also true when looking at session times, using the All Session Times tool.

Learning Book	No. of Students	Minimum Calculated Time	Maximum Calculated Time	Average Calculated Time	Standard Deviation
1	23	12s	1h10m9s	24m7s	24m21s
5	120	25s	1h3m49s	16m26s	11m42s
6	137	6m29s	4h27m46s	1h31m48s	48m9s
8	153	24s	6h49m40s	1h27m57s	1h4m20s
9	130	40s	8h46m20s	2h22m44s	1h17m19s
10	135	21m22s	5h13m46s	1h27m55s	43m37s
12	119	1m4s	8h52m4s	2h5m48s	1h22m50s
13	123	14m1s	8h17s	1h42m17s	1h2m28s
14	120	18m5s	7h11m11s	1h58m5s	1h10m12s
15	110	16m25s	12h20m14s	1h51m46s	1h53m35s
16	106	1m29s	2h59m21s	6h11m23s	4h42m16s
17	77	54s	8h27m32s	1h48m5s	1h13m42s
19	76	1m38s	6h57m3s	31m41s	47m47s
20	80	59m17s	17h6m48s	4h49m12s	3h14m7s
21	78	12m27s	3h23m53s	1h10m37s	36m26s
23	60	4m18s	4h55m33s	2h4m12s	1h1m14s
24	59	22m25s	7h46m56s	3h27m9s	1h49m7s
26	55	31m45s	12h50m37s	4h29m41s	2h23m17s
27	54	4m27s	10h22m9s	2h36m56s	2h17m45s
29	49	32m37s	43h27m58s	14h27m10s	8h29m10s
31	35	6m16s	8h13m43s	2h49m39s	2h4m9s
39	28	1h21m45s	17h54m39s	8h58m22s	3h16m44s

Table 3 The range and average calculated time to study a LearningBook

The amount of (calculated) study time is substantially different from the time recommended by the course team (on average, students spend 58% of recommended time).

Using the 1998 data, the calculated times spent by students working on a particular LearningBook, having made allowance for study breaks of 10 minutes or more, were compared with the time that the course team expect a student to spend working on that LearningBook³. On average, students spent 58% of the recommended time studying a LearningBook.

After looking a wider range of LearningBooks and larger number of student recordings the 2000 data agrees with this. Students spent on average 59% of the recommended time studying a LearningBook.

Figure 1 shows the percentage of the recommended time taken in 1998 data compared with the 2000 data. For both years highest % was taken for LearningBook 12. This has been identified by the course team as a chapter that "falls short of achieving its aims and learning objectives" (Rapanotti & Griffiths, 2001).

³ The recommended times were taken from the M206 course materials provided to students.

The 2000 data shows that students also spend significantly longer than the course team recommends in LearningBook 16. The reason for this may be that this years recordings contain students work on assignments (for which LearningBook 16 is used). If the data for LearningBook 16 is removed from the data the average time spent, students, studying a LearningBook is 51%.

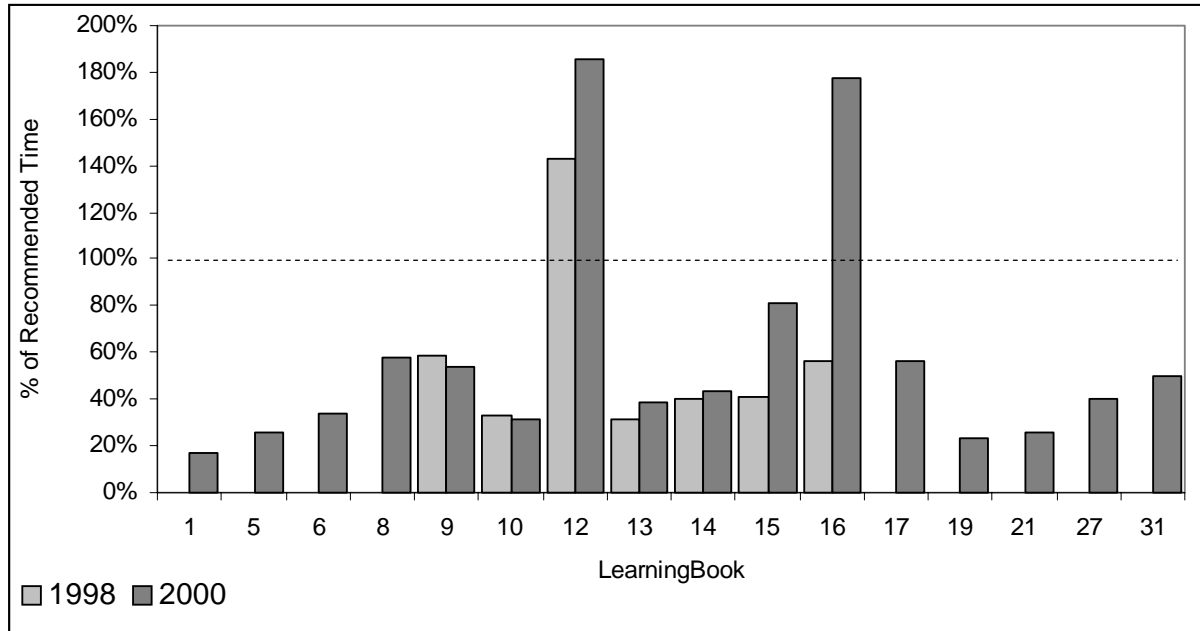


Figure 1 Average calculated time spent in a LearningBook as a % of Recommended study time for 1998 and 2000 data

In general, students tend to try the first session and then either give up or complete the whole LearningBook.

When analysing the 1998 data it was clear that, in general, students tended to try the first session and then either gave up or completed the whole LearningBook.

Using the All Session Times tool with the 2000 data provides a much more detailed picture of student behaviour. Few students only complete only the first session and then give up, although the number of students spending time in a session decreases towards the end of the LearningBooks, as can be seen in Figures 2 and 3. Figure 2 shows the data for LearningBooks 01 to 16 and Figure 3 shows that data for LearningBooks 17 to 31.

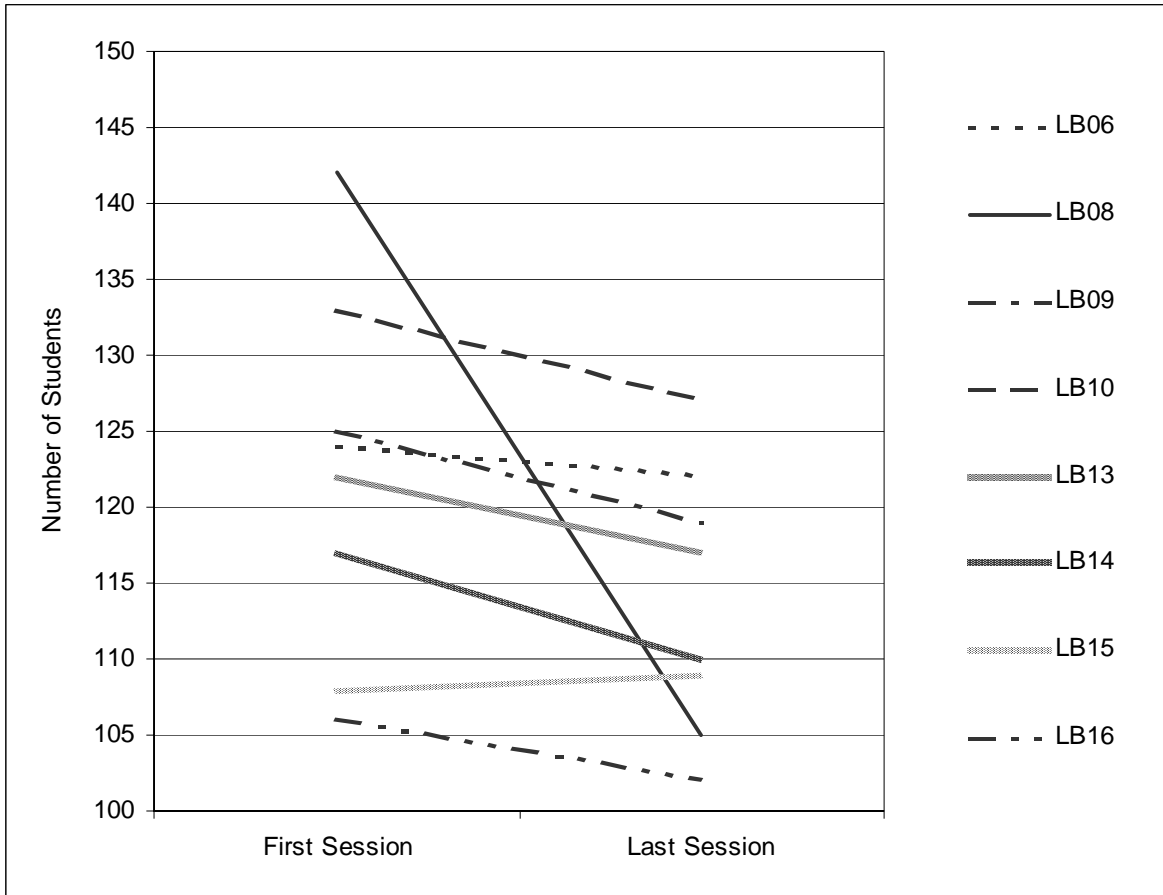


Figure 2 Number of students spending time in the First and Last Sessions of LearningBooks 06-16

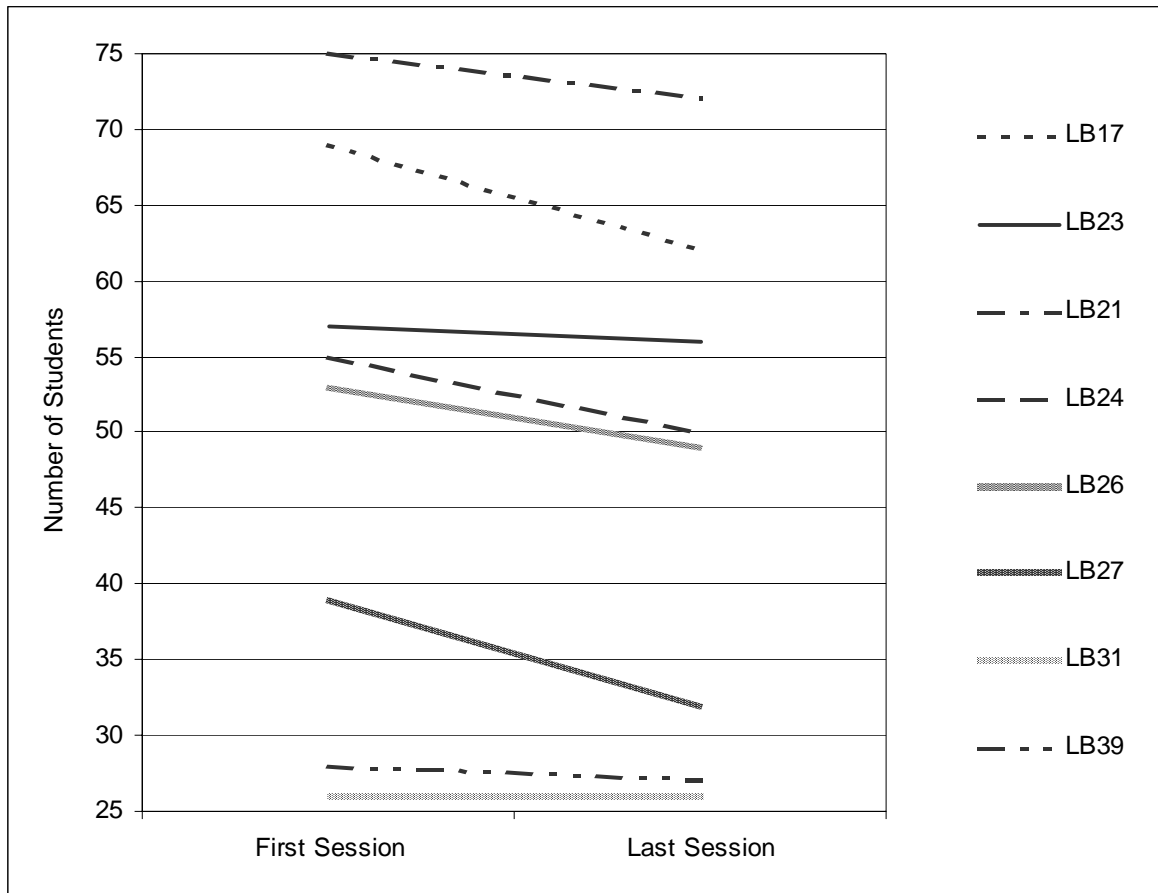


Figure 3 Number of students spending time in the First and Last Sessions of LearningBooks 17-39

It can be seen from Figure 2 that the number of students spending time in the last session of LearningBook 8 is a significantly lower number than student spending time in the first session of the same LearningBook. We could not find any reason for this effect.

From Figures 2 and 3 it can also be seen that LearningBook 15 is the only LearningBook where more students spend time in the last session of the LearningBook than the first session. Since students must use LearningBook 15 in completing an assignment, it is likely that this is the reason for this effect.

It can be seen in Figure 3 that the number of students spending time in the first session and the last session in LearningBooks 31 and 39 appear to be the same. The reason for this may be due to the fact that as these LearningBooks are studied towards the end of the course we have dwindling numbers of student volunteers. Therefore the students still sending in their recordings may be more conscientious and more likely to complete all of the LearningBook. We conjecture that the students who are still prepared to send in recordings have more time to spend on the LearningBooks. In general we would expect students to spend less time on the practical activities as the course progresses (unless an assignment is involved). This is due to time pressures (once a student gets behind it is difficult to make that time up), therefore we will not receive as much data from students as the course progresses as at the beginning of the course.

We hypothesised that the more sessions in a LearningBook contains, the greater the decrease in number of students completing the first session to the last session. However, as Table 4 shows, we found no significant correlation between number of sessions in an LB and the number of students completing first and last sessions.

LB	No. of Sessions in LB	No. of students in first session	No. of students in last session	%
6	5	124	122	98.38
8	4	142	105	73.94
9	4	125	119	95.2
10	5	133	127	95.49
13	3	122	117	95.90
14	3	117	110	94.02
15	2	108	109	100.93
16	3	106	102	96.23
17	4	69	62	89.86
21	5	75	72	96
23	3	57	56	98.25
24	4	55	50	90.91
26	6	53	49	92.45
27	4	39	32	82.05
31	4	26	26	100
39	10	28	27	96.43
Correlation				-0.00213

Table 4 Correlation between number of sessions in a LB and number of students completing first and last sessions

Whilst there is in general, a decrease in numbers of students tacking the last session, some LearningBooks show a small increase for intermediate sessions, as Figures 4 and 5 show.

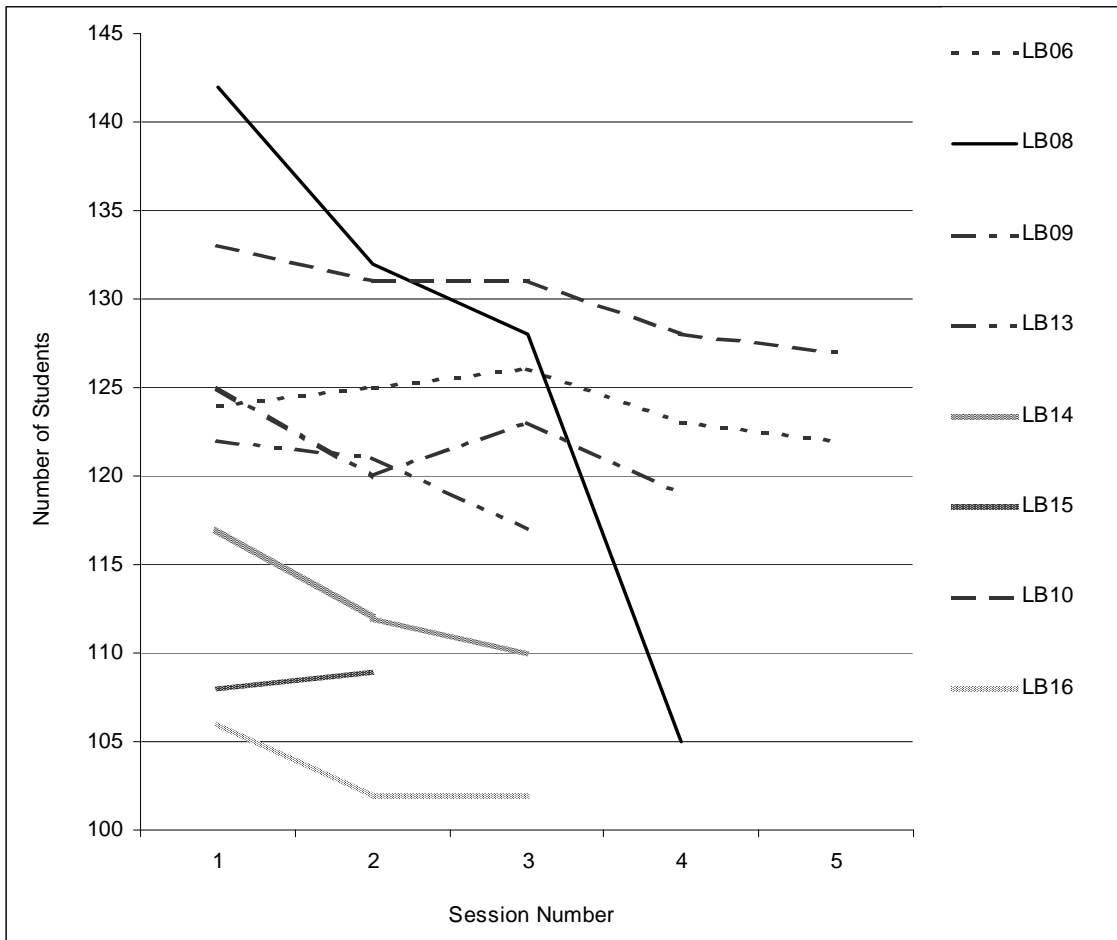


Figure 4 Number of students spending time in each Session of LearningBooks 06-16

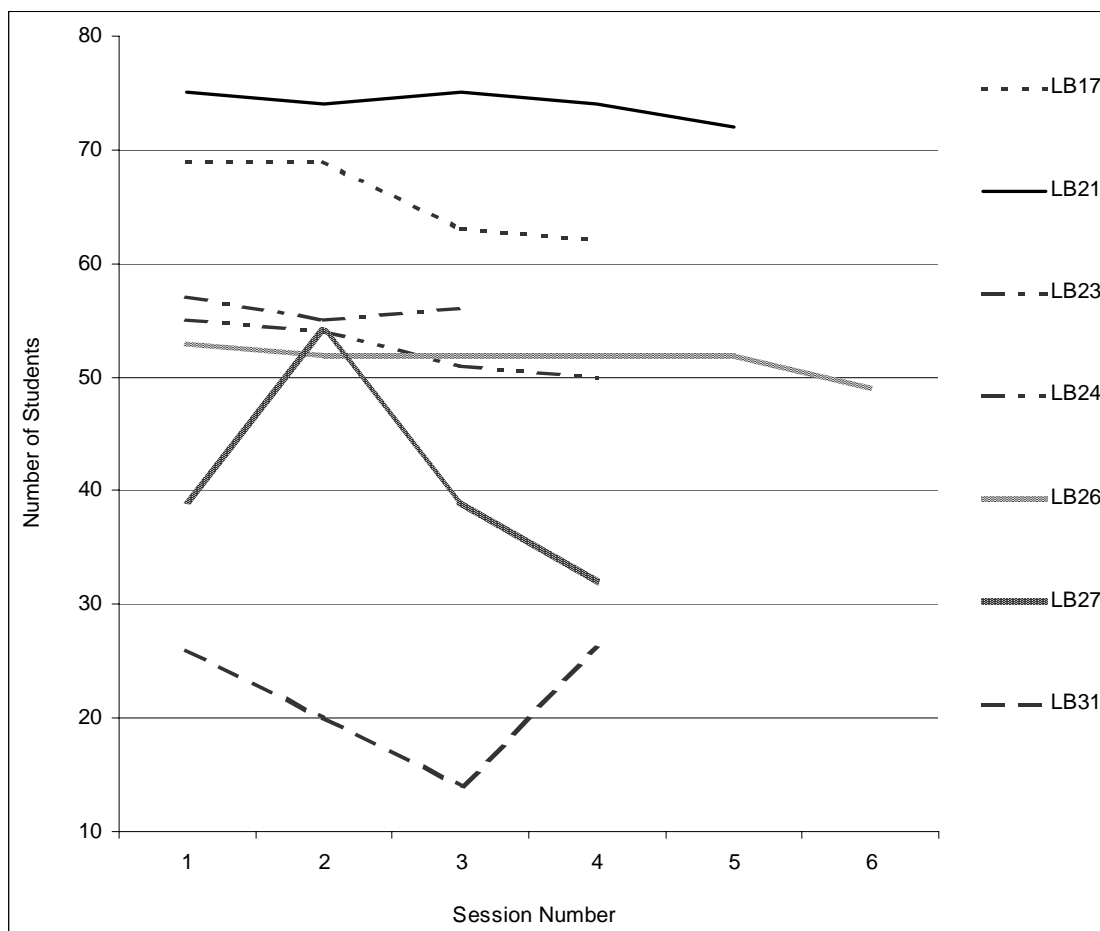


Figure 5 Number of students spending time in each Session of LearningBooks 17-31

Some students repeat some sessions.

The 1998 data showed that some students repeated sessions in a LearningBook. In some cases, students revisited a session in order to complete it, in other cases they repeated some of the tasks. The Analysers new tool does not identify whether students revisit sessions.

The new tools do not allow us to investigate sittings and a new Tasks Completed Tool is required.

References

M206 Computing: An Object-oriented Approach, The Open University (1998)

Goldberg, A., Abell, S., and Leibs, D. (1997) The LearningWorks Delivery and Development Framework, *Communications of the ACM*, 40(10): 78-81.

MacGregor, M, Thomas, P.G., Woodman, M., (1999) Recording and Analysing User Actions in a Smalltalk Programming Environment, *Proceedings of Technology of Object-Oriented Languages and Systems*, Santa Barbara, USA, August 1999.

Rapanotti, L. & Griffiths, R. (2001) M206 Formal Evaluation ?

Thomas, P.G., Martin, M., and Macgregor, M. (1998) Observing Students as they Learn, *ITiCSE 98*, Dublin, August 1998

Thomas, P.G., Martin, M., and Macgregor, M. (1998) AESOP - An Electronic Student Observatory Project, *Frontiers in Education 98*, Phoenix, USA, November 1998

Thomas, P.G. & Paine, C.B. (1999) *How students learn to program: observations of study time behaviour*. Research Report: 2000/02. Computing Department: Open University

Thomas, P.G. and Paine, C.B (2000a) Tools for Observing Study Behaviour, *Psychology of Programming Interest Group Workshop, 2000*, Corilano Calabro, Italy.

Woodman, M., Griffiths, R., Macgregor, M., Holland, S., and Robinson, H.(1999) Exploiting Smalltalk Modules In A Customisable Programming Environment, *Proceedings of ICSE 21, International Conference on Software Engineering*, Los Angeles, May 1999.