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A Preliminary Study of Student Workload for IGNOU Physics Elective Courses

SURESH GARG and VIJAYSHRE

School of Sciences, Indira Gandhi National Open University, New Delhi-110068, India

SANTOSH PANDA

Division of Distance Education, Indira Gandhi National Open University, New Delhi-110068, India

The Indira Gandhi National Open University has recently launched the Bachelor's Degree Programme in Science as a pilot project. The authors have estimated student workload for physics electives on offer at the first level and provided a possible framework for future action in this area. They are of the view that in the thinking of the programme designers, goals of distance education have not sufficiently replaced the norms and requirements of the conventional system. This has created an imbalance which may be detrimental to distance education students. They advocate a more realistic application of the norms of distance education to the courses designed for B.Sc. students.

Here it needs to be noted that academic conservatism shall not favour reduction of academic inputs in distance education courses in comparison with those in the corresponding conventional courses. For the sake of credibility, the practitioners of distance education would not like to favour such reduction either. Isn't it reasonable, therefore, to fix a realistic period of time, longer than the present three years, as the minimum duration to complete the BDP programme?

INTRODUCTION

Though almost three decades ago, the Indian University Grants Commission (UGC) recommended that undergraduate (UG) Courses should be redesigned and related to our socio-economic conditions, even the leading universities in the country have failed to respond befittingly to design a curriculum which provides for the optimum growth and development of the potential endowed in an individual. As a result, the undergraduate curriculum has remained one of the most important areas of concern in higher education today. The establishment of the Indira Gandhi National Open University (IGNOU) in 1985 provided an opportunity to reform the UG curricula in vogue in the conventional universities and relate them to short-term as well as long term socio-politico-economic needs of our society. Indeed, IGNOU has taken the lead in reforming the UG curriculum along the lines recommended by the UGC for conventional universities.

IGNOU introduced the Bachelor's Degree Programme (BDP) in 1989 and the UG Science programme in December 1991- January 1992, characterised by a three-tier course structure: *foundation courses, electives* and *application- oriented courses*. The Foundation Courses in Science and Technology (FST-1), and Humanities and Social Sciences (FHS- 1) provide a broadbase to the curriculum content, encompassing the current concerns of our society in a historical perspective. These courses aim at: generating socio-political awareness in the learners, developing the ability to critically reflect upon issues pertaining to science-society relationship, sensitising the learners to social concerns like national integration and illiteracy, fostering scientific temper, and developing appreciation for equitable development, peace and disarmament. Through these courses, a definite effort has been made to provide a perspective in which these concerns should be viewed. In a sense, these courses intend to bring about attitudinal changes in the learners. In addition, the Foundation Courses in English and Hindi languages aim at developing the linguistic competence required for undertaking the subsequent elective courses.

The Elective Courses provide for core areas of study in a discipline. The knowledge gained through them is further sharpened by the Application-oriented Courses — an important innovation in the undergraduate curriculum in the country. Courses like Human Environment, Computer Programming and Applications, and Environmental Chemistry aim at providing interdisciplinary perspectives and developing vocational skills that should prepare the learners to undertake public/ private/ self-employment.

There is no denying the fact that while drawing up an innovative undergraduate curriculum, the programme designers have been influenced by the existing undergraduate programmes in the conventional universities to ensure recognition of the degree by the conventional universities as well as prospective employers. For the

B.Sc. programme (within the BDP framework), special care has been taken to overcome the misconceptions of academics that: i) science education through distance mode is a less effective mode of instruction compared to science education on-campus, and ii) it is a refuge for failures of the formal system.

To qualify for the award of a Bachelor's degree, a student has to earn a total of 96 credits (where one credit is equivalent to 30 student study hours), i.e., he/she must complete 24 credits worth Foundation Courses, 56-64 Credits of Elective Courses and 8-16 credits of Application-oriented Courses. This suggests that nearly two-thirds of student study time at IGNOU is devoted to the Elective Courses in core disciplines.

Besides the printed course units that dominate the course materials, the audio and video programmes are an integral part of the multi-media package offered by the university; these programmes supplement the self-instructional print materials. In particular, the video and television programmes are used to illustrate concepts and phenomena which are difficult to present in print as well as the face-to-face teaching. We have used the video facility to illustrate the concepts about the universe, health care, modelling by differential equation etc. Furthermore, to meet the belief that for understanding scientific concepts, face-to-face contact is a must, the university has introduced academic-counselling sessions and summer schools for the benefit of its learners.

The entire BDP consisting of 96 credits has been made equivalent to the 3-year undergraduate programme of the on-campus full-time scholars. For the B.Sc. undergraduate programme, however, it is realised that in spite of the conscious efforts made earlier to eliminate the repetitive and outdated elements, the content of Elective Courses alone, worth 56-64 credits, is equivalent to the content of the entire undergraduate science programme of the conventional universities! This stems from the overriding concern that our learners must not gain less knowledge compared to the full-time on-campus students. This necessitates careful re-examination of "student workload" and its implications in course and curriculum design. For this, we would specifically refer to the Physics Electives (theory) on offer at the first level of BDP (B.Sc.) at IGNOU, namely, "Elementary Mechanics" and "Oscillations and Waves". A detailed list of proposed physics electives is given in Table 1.

Table 1: Physics Electives Offered to Undergraduate Science Students of IGNOU with Corresponding Credits

Level*	Elective Course	Credit Worth
I	Elementary Mechanics	2
	Oscillations and Waves	2
	Physics Laboratory-I	4
II	Mathematical Methods in Physics-I	2
	Mathematical Methods in Physics-II	2
	Thermodynamics and Statistical Mechanics	4
	Electric and Magnetic Phenomena	4
	Physics Laboratory-II	4
III	Optics (Physical and Laser)	4
	Modern Physics	4
	Electrical Circuits and Electronics	4
	Physics Laboratory-III	4

* The levels are notional in the sense that these courses will be offered sequentially to BDP (Sc.) students in the first three years of the launching of the course. Subsequently, a student can, in principle, offer any of these courses.

Our aim should, no doubt, be to enhance the quality of learning which depends, to a great extent, on the approach to learning. Therefore, we shall first examine the various approaches to learning the students undertake, which depend upon many important factors including the "workload"

APPROACHES TO LEARNING

Two approaches to learning - deep and surface - were identified by Marton and Saljo (1976). A deep learner tries to understand the concept, relates new ideas and concepts to previous knowledge and everyday experience, adopts an enquiring and critical stance, examines the logic of an argument, and seeks evidence to support conclusions. In deep learning, the stress is on acquisition of the skills necessary for problem solving. A surface learner, on the contrary, tries to complete the task at hand. This involves memorisation of information, reproduction of unrelated ideas and facts from the point of view of examination, and reflection on the purpose of learning. Research at Lancaster University by Entwistle and Ramsden (1983) and Ramsden (1988) has extended and established these approaches to three types: deep, surface and strategic approaches to learning, corresponding to **meaning, reproducing** and **achieving** orientations to study respectively. A strategic learner always tries to formulate strategies to obtain the highest possible grades with minimum effort. This involves optimum organisation of time and effort, use of previous examination papers to predict possible questions, alertness to cues about marking schemes, and arrangement of appropriate conditions and materials for studying. The performance of the strategic learner is solely guided by pragmatic considerations. The conclusion drawn from these studies could be summarised as follows: that student approaches to learning i) influence the quality of learning and ii) are, in turn, affected by the quality of teaching, forms of assessment, student workload, and other related variables.

The experiences of the authors in teaching at conventional universities show that deep learners are always few in number; the majority of the students belong to either surface or strategic category. While we, in the distance teaching institutions, would like our students to be self- motivated deep learners, there is a lurking fear that most of them may turn towards strategic learning with the sole purpose of acquiring better grades. This poses a serious challenge to the distance teachers. To motivate the learners towards deep learning, two considerations assume importance: rich quality of content, and good teaching practice. Hirst and Peters (1970) have identified three conditions necessary for good teaching practice. Activities that bring about learning

* "must be conducted with the intention of bringing about learning"
* "must indicate or exhibit what is to be learnt"
* "must do this in a way which is intelligible to, and within the capacities of, the learners" (1970: 81).

We are specifically concerned with the third condition - workload as per the capacity of the learner.

WORKLOAD AND EFFECTIVE LEARNING

Research has established that the amount of time a student devotes to study is an important factor in effective learning. Ramsden (1988) has remarked that enough time should be made available to the students to "relate and distinguish new ideas and previous knowledge, relate concepts to everyday experience, relate and distinguish evidence and argument, organise and structure content". Students also need help to gain a perspective on what they are studying, why and how they are studying it, and a concern for learning themselves (Chambers, 1992). These, alongwith the findings of research studies on processes of student learning (Marsh, 1987; Entwistle and Tait, 1990) stress the undeniable importance of student workload. There was a clear evidence of correspondence of overloaded tasks to memorising, and of over-demanding courses and bad teaching to poor performance in the examination (Entwistte and Tait, 1990). Moreover, there is a relationship between perception of difficulty and interest in the topic (Chambers, 1984); students are not able to work longer if the subject matter is experienced difficult (Chambers, 1976); and students finding a course very difficult feel more anxious and overburdened, which further affects their studies (Chambers et al, 1989). For deep and effective learning, students need help and time to develop individual perspectives on the subject matter. It should be the primary concern of course designers and course writers to develop such learning in the students.

> "In particular, it implies that teachers may actually need to restrict the scope of a curriculum, especially in the early stages of students' careers, in order to make the time and provide incentives for them to behave appropriately; to think; go back over things; work towards the broader frame and context from and within which to make their own meanings (individually and in group settings); experiment with their writing; and come to understanding of how important it is that they begin to find their own 'voice' within these discourses. If students do not have time to do these things, if they are always driven on by the demands of the curriculum, we leave them little choice but to skim along on the 'surface' of things, merely echoing their teachers' voices" (Chambers, 1992:145).

In India, the science curriculum is so loaded, especially at the primary and secondary stages,that students invariably fall short of time to go deep in their studies, and most of them are left with no choice but to adopt a surface or strategic approach to learning. This has been one of the important factors related to student dropout. Researchers in distance education have found that heavy workload is one of the important course-related factors responsible for student dropout in distance education (Woodley and Parlett, 1983). This issue forces us to seriously consider the question of time devoted to study and optimisation of student workload for effective learning. In conventional face-to-face teaching-learning, which is mainly a teacher-/course-centred group learning, it becomes easier for the teacher to pay individual attention to students, monitor their progress and accordingly adjust the academic situation to their demands. Both in group lectures and in tutorials/individual consultancies, a teacher enjoys considerable autonomy and scope to cater to individual deficiencies, and adjust workload with individual learning strategies.

The situation described above is difficult to maintain in open universities practising distance teaching-learning, with varied multi-media combinations across courses/programmes. The distance teachers try, through simple and conversational language, self-assessment and continuous feedback, reinforcements, illustrations and examples, etc., to make contents easily comprehensible, interesting and effective. The problem before them is to achieve effective learning through these packages within the **prescribed/allocated time.** Most often, the allocated time frame becomes too ideal to maintain because of the constraints imposed by delay in printing and delivery of course materials, increasing turn-around time of assignments, and the constraints imposed by the study centres, and the over-calculation of the quantum of learning to be achieved within a prescribed time frame. The time schedule framed for the student should take into account, apart from the scattered geographical locations, the demands of his/her profession, family and other responsibilities.

So far as the undergraduate curriculum at IGNOU is concerned, the question before us is: How much time should we ask our students to devote to each unit/block/course? In the absence of developmental testing of the materials, *post-facto* survey and sufficient feedback from course writers, course coordinators, editors, educational technologists, academic-counsellors, and even by the conventional university teachers concerned, it is necessary to develop constant introspection as an indicator to depend upon. Even professional responsibility demands such an analysis, more so when we wish to offer distance learning as an effective apparatus for pursuing learning by heterogeneous population, who were deprived of higher education earlier. This brings us to the description of assessing student workload. Assessment of Student Workload

ASSESSMENT OF STUDENT WORKLOAD

As we have said earlier, an IGNOU student is required to accumulate a total of 96 credits to successfully complete the Bachelor's Degree Programme (BDP), where one credit is equivalent to thirty student study hours, involving activities, viz., reading and comprehending course units, working on assignments, viewing/listening video/audio programmes and the national broadcasts, attending academic- counselling sessions, preparing for and writing term-end exam papers, etc. Though attending academic-counselling sessions is optional, a B.Sc. student is supposed to attend Summer Schools as a compulsory component of the course work.

Finding out student workload would involve allocating time to each of these components of the entire BDP. The procedure for time allocation to these components can be adopted keeping the "average student" in view. To discover whether or not the course is overloaded, the time allocated by IGNOU, i.e., 2880 student hours to complete the BDP, could be matched with either the actual time taken by the students or the time suggested by the team of course writers, designers, etc., or even by both. In other words, this would clearly reveal whether the entire BDP (B.Sc. in this case) is worth 96 credits or more.

Chambers (1992) notes two important successful methods of estimating student workload. In the one adopted by McKay (1978), students were asked to report in retrospect how much time they devoted to study a particular course; in the other, adopted by the University Grants Committee (1964) of UK, the full-time undergraduates were asked to maintain a work log to record the time devoted to study after each work session. In the first method of retrospective reporting by the students, the reporting of exact rating of the workload may not be reliable due to the influence of their own perceptions of the difficulty level of a particular task, and the impact of their interest in a task or topic on their judgement. Limitations in the second method, are unreliable record-keeping by the students and the underestimation of actual workload stemming from their feeling of being pressurised by and being at par with teachers' expectations. Therefore, all these methods of retrospective assessment, workload perception and maintenance of workload log seem to be inadequate to ensure accuracy in the calculation of workload.

The method that we should adopt must take into account:

* a reasonable assessment of how long it takes for an average student to complete a range of tasks;
* the recognition that the students are not necessarily going to be academics in future, but to enter a range of professions; and
* the objective that distance teaching must encourage deep learning.

As noted earlier, for the full-time undergraduates it takes three years to complete the degree programme and IGNOU has also fixed three years (or, in other words, 2,880 hours or 96 credits on the basis of IGNOU's parameters) as the minimum time required for a part-time distance learner to successfully complete the BDP (including the B.Sc. programme). While, on the one hand, it is doubtful whether variations in student study patterns and workload have been taken into account to calculate the time needed to complete the undergraduate study by the full-time students, on the other hand, it is also equally doubtful whether IGNOU has taken into account the strategies contributing to deep learning (without necessarily attempting to equate its workload with that of the full-time campus-based education). The density and difficulty level, and the length of courses that vary from subject to subject, and also within the same subject area, must be considered in the calculation of student workload, whatever be the method.

For our purpose in this paper, we have adapted the method suggested by Chambers (1992), which is an improvement over the two other methods noted earlier. Chambers and her colleagues have successfully applied the method in the UKOU Arts Faculty courses. The method gives weightage to various aspects of course and student learning, viz., difficulty level, length and density of printed units, time taken by students for thinking while reading/re-reading materials (and studying diagrams and tables, etc.), making notes, and so on. She has quoted Lockwood et al's (1988) experimental work on "reading speeds in relation to comprehension" based on the following rule-of-thumb with regard to words per minute (wpm) :

i)	an easy read	:	100 w.p.m.
ii)	a fairly straightforward text	:	70 w.p.m.
iii)	a dense/difficult text	:	40 w.p.m.

The rates noted above are regarded as "study times or rates" (and not "reading rates") because they involve reading in relation to comprehension, and encompass time for thinking, re-reading, note-taking, etc. Chambers noted that this rule-of-thumb was based on the assumption that the students are relatively unskilled readers and the study materials are unfamiliar to them. However, these rates might vary from course to course, and from one discipline to another, depending on the complexities specific to each discipline. With regard to this, Chambers notes that:

> "... a compromise has to be made between what teachers regard it as necessary to teach and how much time students can reasonably be expected to spend studying .... a judgement does have to be made about how long it will take the 'average' student to study each one" (1992 : 149).

The authors are conscious of a few exploratory studies conducted by individual academics for social sciences and mathematics courses at IGNOU. The studies, as action research, have been utilised by those academics in bringing about changes in their respective courses at the BDP level, but have not been formally reported so far. The preliminary results of the on-going study by Parashar, Panda and Garg (1991) suggest that the constraint of workload impedes smooth progress of the students of Management Courses at IGNOU. All the above studies point out that though the IGNOU courses are widely appreciated for the richness of content, they have been pitched at a slightly higher standard than what an average student at the BDP level can cope with. It could be drawn from the above discussion that while on the one hand the IGNOU course materials have been appreciated as better than what is available in the market, they are too exhaustive and dense for the average student.

It should also be kept in mind that the rule-of-thumb prescribed for the UKOU students may not be exactly applicable to the students of IGNOU. Even if we assume that an average IGNOU undergraduate student would be at par in mental abilities with a UKOU student, the former would take longer time to study an English medium science text than the latter, because of English being the second language for most of them.

In the case of our consideration of workload for Physics elective courses, on the basis of our interview with a group of sampled students, a few academic-counsellors, course writers and course editors concerned, the following "study time" is proposed as a rule-of-thumb for the Physics courses of IGNOU. Our calculation has taken into account the density and difficulty level and length of these courses.

i)	an easy read	:	60 w.p.m.
ii)	a fairly straightforward text	:	40 w.p.m.
iii)	a dense/difficult text	:	25 w.p.m.
iv)	difficult mathematical equation/step	:	1 min. per equation

Keeping in mind the individual variations, the average time taken for illustrations and exercises within the text, audio and video programmes, assignments, etc. has been calculated. To consider a few instances: some diagrams need to be worked through and therefore need greater attention than those which require a cursory glance; certain exercises test only knowledge and comprehension, while others could be more challenging by putting the learner in problem-solving situations. The diagrams requiring greater attention, the more challenging exercises, etc. would demand more student time than others.

Using the modified version based on Chambers (1992) and Lockwood et al (1988) and our consultations with course designers, course writers, academic-counsellors and students, we have calculated study time required for two Physics elective courses: **Elementary Mechanics** and **Oscillations and Waves,** each worth 2-credits (1 credit equivalent to 30 student study hours). Table 2 records the Units contained in these courses: consisting of 2 Blocks each with a total of 10 and 9 units respectively. Tables 3, 4 and 5 contain the activity-wise break up of estimated time for these courses. We find that the estimated student study hours for the two courses are 91 hours and 88 hours respectively. This means that in our estimate both the courses are worth three credits each, instead of the prescribed 2 credits. That is, the courses are overloaded. This is largely because of the content density as well as the level of the courses. For instance topics like "Scattering" and "Motion in non-inertial frames of reference" of Elementary Mechanics could be shifted to higher level courses or given just for general information with much less mathematical details. These were retained basically to keep parity with the conventional curriculum. This calls for a careful reorganisation of the course contents and reduction of their scope. Though the course designers/developers seem to be guided by the overriding concern about the credibility of open system, care has to be taken that the teaching practices, in particular the curriculum content, encourage deep learning. Moreover, these concerns should not demotivate students forcing them to drop out. Immediate remedial measures can also be taken to avoid overburdening the students. It is suggested that

* developmental testing of course materials on a group of prospective students must be done for each course and a *post-facto* feedback mechanism should be evolved, and
* conscious effort should be made to delink open university curriculum from overriding concerns of conventional universities.

With this in view we would argue for restructuring and redesigning of the contents of these physics electives. The emphasis should be on developing the basic conceptual schemes and processes which lie at the core of the discipline, rather than loading the courses with a bulk of information and mathematical details. Teaching practices should encourage self-learning among students. These should aim to develop abilities among students that enable them to handle with confidence any new learning situations they may encounter.

Table 2 : Units Constituting Courses Under Study

Course	Block 1 (Units)	Block 2 (Units)
Elementary Mechanics	Motion	Motion under Central Conservative Forces
	Forces and Momentum	Many-Particle Systems
	Work and Energy	Scattering
	Angular Motion	Rigid Body Dynamics
	Gravitation	Motion in Non-Inertial Frames of Reference
Oscillations and Waves	Simple Harmonic Motion	Wave Motion
	Superposition of Simple Harmonic Oscillations	Waves at the Boundary of Two Media
	Damped Harmonic Motion	Superpositon of Waves-I
	Forced Oscillations and Resonance	Superpositon of Waves-II
	Coupled Oscillations	

Table 3: Activity-wise Break up of Estimated Study Time for Print Material of Elementary Mechanics

Unit	Study Time required for (minutes)			Total Time
	Text including Mathematical steps	*SAQs, TQs and Examples	Diagrams and Tables	
Motion	155	140	25	320
Force and Momentum	100	205	15	320
Work and Energy	160	145	20	325
Angular Motion	170	170	60	400
Gravitation	110	120	35	265
Motion under Central Conservative Forces	110	135	15	260
Many-Particle Systems	135	200	25	360
Scattering	195	45	50	390
Rigid Body Dynamics	175	180	90	445
Motion in Non-Inertial Frames of Reference	200	145	50	395
				57 hours

* SAQs – Self-assessment questions, TQs – Terminal questions

Table 4 : Activity-wise Break up of Estimated Time for Print Materials of Oscillations and Waves

Unit	Time (in minutes) required for			Total Time (minutes)
	Text including Mathematical Steps	SAQs, TQs and Examples	Diagrams	
Simple Harmonic Motion	210	120	30	360
Superposition of Harmonic Oscillations	180	60	30	270
Damped Harmonic Motion	210	90	90	390
Forced Oscillations and Resonance	300	45	15	360
Coupled Oscillations	300	150	30	480
Wave Motion	300	90	30	420
Waves at the Boundary of Two Media	300	120	30	450
Superposition of Waves - I	150	60	30	240
Superpositon of Waves - II	180	60	30	270
				54 hours

Table 5 : Estimated Time for Miscellaneous Activities

Course	Activity Time (in hours) Required for				Total Time (hours)
	Assignments	Attending Counselling and A/V Sessions*	Correspondence with Hqrs	Preparation for Examination	
Elementary Mechanics	6	7	1	20	34
Oscillations and Waves	5	8	1	20	34

* This does not include the time spent by the student in commuting between his/her home and the Study Centre.

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