Promoting higher quality

The Quality Assurance Agency
for Higher Education

Subject Review Report

December 1999 Q113/2000

University of Keele

Physics and Astronomy

Reviewing the Quality of Education

The Quality Assurance Agency for Higher Education (QAA) was established in 1997. It has responsibility for assessing the quality of higher education (HE) in England and Northern Ireland from 1 October 1997 under the terms of a contract with the Higher Education Funding Council for England (HEFCE).

The purposes of subject review are: to ensure that the public funding provided is supporting education of an acceptable quality, to provide public information on that education through the publication of reports such as this one, and to provide information and insights to encourage improvements in education.

The main features of the subject review method are:

Review against Aims and Objectives

The HE sector in England and Northern Ireland is diverse. The HEFCE funds education in over 140 institutions of HE and 75 further education (FE) colleges. These institutions vary greatly in size, subject provision, history and statement of purpose. Each has autonomy to determine its institutional mission, and its specific aims and objectives at subject level.

Subject review is carried out in relation to the subject aims and objectives set by each provider. It measures the extent to which each subject provider is successful in achieving its aims and objectives.

Readers should be cautious in making comparisons of subject providers solely on the basis of subject review outcomes. Comparisons between providers with substantively different aims and objectives would have little validity.

Review of the Student Learning Experience and Student Achievement

Subject review examines the wide range of influences that shape the learning experiences and achievements of students. It covers the full breadth of teaching and learning activities, including: direct observation of classroom/seminar/workshop/ laboratory situations, the methods of reviewing students' work, students' work and achievements, the curriculum, staff and staff development, the application of resources (library, information technology, equipment), and student support and guidance. This range of activities is captured within a core set of six aspects of provision, each of which is graded on a four-point scale (1 to 4), in ascending order of merit.

The aspects of provision are:

- Curriculum Design, Content and Organisation
- Teaching, Learning and Assessment
- Student Progression and Achievement
- Student Support and Guidance
- Learning Resources
- Quality Management and Enhancement.

Peer Review

Reviewers are academic and professional peers in the subject. Most are members of the academic staff of UK HE institutions. Others are drawn from industry, commerce, private practice and the professions.

Combination of Internal and External Processes

The review method has two main processes:

- Preparation by the subject provider of a self-assessment in the subject, based on the provider's own aims and objectives, and set out in the structure provided by the core set of aspects of provision.
- A three-day review visit carried out by a team of reviewers. The review team grades each of the aspects of provision to make a graded profile of the provision, and derives from that profile an overall judgement. Provided that each aspect is graded 2 or better, the quality of the education is approved.

Published Reports

In addition to individual review reports, the QAA will publish subject overview reports at the conclusion of reviews in a subject. The subject overview reports are distributed widely to schools and FE colleges, public libraries and careers services. Both the review reports and the subject overview reports are available in hard copy and are also on the world-wide web (see back cover for details).

Introduction

1. This Report presents the findings of a review in December 1999 of the quality of education in physics and astronomy provided by the University of Keele.

2. The University was founded in 1949 as the University College of North Staffordshire and attained university status in 1962. It is situated on a large rural campus in Staffordshire. The University's academic work is organised through academic schools and departments which are grouped into four faculties. There are some 4,700 full-time undergraduate students, with a further 2,500 part-time students (mostly continuing education and nursing and midwifery students). In addition, there are 750 full-time and 700 part-time postgraduate students. Some 90 per cent of full-time undergraduate students follow the University's distinctive dual honours degree programme in which they combine two principal subjects. They are also required to take at least one subsidiary course in the first year. The Department of Physics is located within the School of Chemistry and Physics.

3. There are approximately 100 students following principal undergraduate programmes in physics and astrophysics, with a further 260 students from other departments following subsidiary courses in physics or astronomy. There are 17 academic staff (11.7 full-time equivalent) supported by 10 technical and four administrative staff.

4. The following provision forms the basis of the review:

- BSc/MSci/MPhys (Hons):
  - Principal Physics
  - Principal Astrophysics
  - Principal Electronics
  - Integrated Single Honours Physics
  - Integrated Single Honours Astrophysics
- Physics components of BSc Principal Biomedical Sciences and BSc Principal Physiotherapy
- Subsidiary Astronomy
- Subsidiary Electronics.

5. The statistical data in this Introduction are provided by the institution itself. The aims and the objectives are presented overleaf. These also are provided by the institution.

The Aims and Objectives for Physics and Astronomy

Aims

The University's educational aims include:

1. providing an education which includes substantial grounding in at least two disciplines, and which enables all undergraduates to study some science together with some humanities or social science;

2. maximising the social and economic benefits of the University experience by equipping students with skills and knowledge which are transferable into post-University experience.

Departmental Aims

1. To prepare graduates with appropriate principal subject combinations (i) to operate effectively as professional physicists in industrial, commercial or research organisations, or (ii) for progression to academic research and academic careers in physics, astrophysics and cognate disciplines.

2. To prepare graduates to use the analytical skills and the knowledge gained from scientific training in physics/astrophysics alongside those gained from their other discipline(s) in a wide variety of employment roles.

3. To contribute to the interdisciplinary undergraduate programmes in biomedical sciences and physiotherapy, and to provide undergraduate students in biomedical sciences with an appreciation of the role of physics and technology in biomedicine.

4. To contribute to the University's multidisciplinary mission by offering subsidiary courses.

5. To use the Department's research activities to inform the undergraduate programme through projects and specialist modules.

6. To raise awareness of physics and astrophysics in the local community by taking part in, and organising, 'Public Understanding of Science' and similar events, and to offer support to local schools and sixth form colleges in teaching physics and astrophysics.

Objectives

MSci/MPhys students study a greater range of topics in physics/astrophysics than those following the three-year single honours programme, who in turn study a greater range than those taking dual honours. Students following MSci/MPhys programmes experience greater depth in the year four project.

1. Graduates in physics/astrophysics will have achieved - through participation in formal classes, directed and private study - knowledge and understanding commensurate with their degree award, of the fundamentals of physics/astrophysics, and will be able to apply this knowledge and understanding to problems in these disciplines.

2. Graduates in physics/astrophysics will have developed competence in the application of mathematics and, where appropriate, computer simulation and analysis, to physical/astrophysical problems. At Levels 1/2, they will have achieved competence in laboratory activities, and at Levels 3 (BSc/MSci/MPhys) and 4 (MPhys/MSci) undertaken individual project work.

3. Graduates in Biomedical Sciences will have acquired - through participation in formal classes, directed and private study - an appreciation, commensurate with their award, of the relevance of physical science and technology to biomedicine, and understanding of relevant physics and electronics fundamentals. At Levels 1/2 they will have experienced practical work, and undertaken a project at Level 3.

4. Students successfully completing a subsidiary course will have developed their awareness of scientific methods and acquired sufficient knowledge, for example, to be able to follow media coverage of topics covered in the courses.

5. Students obtaining a BSc in physics/astrophysics will have developed skills, including the ability to learn, to work with others, to record observations and communicate findings, and to organise their work. MPhys/MSci students will have received training in research methods and undertaken a major research project.

Summary of the Review

6. The graded profile in paragraph 7 indicates the extent to which the student learning experience and achievement demonstrate that the aims and objectives set by the subject provider are being met. The tests and the criteria applied by the reviewers are these:

Aspects of provision

1. Curriculum Design, Content and Organisation
2. Teaching, Learning and Assessment
3. Student Progression and Achievement
4. Student Support and Guidance
5. Learning Resources
6. Quality Management and Enhancement.

Tests to be applied

To what extent do the student learning experience and student achievement, within this aspect of provision, contribute to meeting the objectives set by the subject provider?

Do the objectives set, and the level of attainment of those objectives, allow the aims set by the subject provider to be met?

Scale points

1
The aims and/or objectives set by the subject provider are not met; there are major shortcomings that must be rectified.

2
This aspect makes an acceptable contribution to the attainment of the stated objectives, but significant improvement could be made.

The aims set by the subject provider are broadly met.

3
This aspect makes a substantial contribution to the attainment of the stated objectives; however, there is scope for improvement.

The aims set by the subject provider are substantially met.

4
This aspect makes a full contribution to the attainment of the stated objectives.

The aims set by the subject provider are met.

7. The grades awarded as a result of the review are:

Aspects of provision	Grade
Curriculum Design, Content and Organisation	4
Teaching, Learning and Assessment	4
Student Progression and Achievement	4
Student Support and Guidance	4
Learning Resources	3
Quality Management and Enhancement	3

8. The quality of education in physics and astronomy at the University of Keele is **approved.**

The Quality of Education

Curriculum Design, Content and Organisation

9. The design and content of the curricula of all the degree programmes are appropriate in level, breadth and depth for the intended learning outcomes. The Principal Physics and Astrophysics courses and the Integrated Single Honours courses share substantial core modules that provide a good basis for university-level study of both physics and astrophysics. The core modules are supplemented by more specialised and optional modules that allow students to develop their particular interests. Curriculum design is informed by input from employers who make up an Advisory Board; this meets regularly and is influential in defining the output attributes needed in graduates.

10. The four-year MSci courses diverge from the three-year Principal Physics and Astrophysics courses at the beginning of the third year by continuing to offer breadth and by introducing training in research before students embark on a substantial research project. Similarly, the four-year MPhys courses diverge from the single honours programmes at the beginning of year three. They provide additional options and the same research-related activities as in the MSci. The longer courses are well suited to preparing students for work as professional scientists or for progression to research and academic careers in relevant fields. The programmes are accredited by the Institute of Physics, the relevant professional body.

11. The physics components of the Biomedical Sciences curriculum provide a substantial and rigorous contribution to a demanding interdisciplinary programme. Graduates have a good understanding of the role of physics and related technology in contemporary biomedicine. The physics contribution to the Physiotherapy degree is similarly effective.

12. The curricula of all the courses have considerable breadth of content, in fulfilment of the University's stated aim. Moreover, students are provided with substantial and commendable choice both at initial enrolment and during the first two years. Transfer between levels is facilitated by curricula which build progressively on core first and second-year courses. The admirable combination of curriculum breadth and depth that is evident in all programmes makes considerable demands on the students, particularly in the first year, for which students have varying levels of preparedness. Strenuous efforts are made to offer students individually tailored support, and recent modifications have been made to the programmes in order to improve progression for those students who have limited mathematical backgrounds. Staff are aware of the need to monitor the success of the modifications and their impact on subsequent years.

13. The courses are characterised not only by thorough coverage of core subject areas but also by systematic and progressive introduction of professional and transferable skills. These include mathematical skills, computational skills, teamworking, written and oral presentation skills and, for MSci and MPhys students, a range of research-related skills. The strong project elements in years two, three and four provide a context for both skills development and in-depth investigation of the chosen project areas. However, the range of year three and year four experimental physics projects available is constrained by the limited experimental physics research base in the Department of Physics. The Department may wish to consider whether there is an over-reliance on simulation.

14. The Subsidiary Astronomy and Electronics courses are very successful in engaging large numbers of students from outside the subject area. They enable students from other disciplines to broaden their education in areas of physics, astrophysics and electronics that are of wider interest.

15. As the curriculum is informed by and reflects the research interests of the academic staff, there is authoritative input to lectures, tutorials and, notably, supervision. However, the Department may wish to consider whether the astrophysics curriculum in the first and second years should be changed to include the study of planets and galaxies, areas of importance which lie outside the research interests of staff.

16. This aspect makes a full contribution to the attainment of the stated objectives. The aims set by the subject provider are met.

Curriculum Design, Content and Organisation: Grade 4.

Teaching, Learning and Assessment

17. The discipline's approach to teaching and learning is based on lectures, regular small-group tutorials, structured laboratory classes and open-ended projects. The tutorials consolidate understanding, develop communication skills, provide feedback and encourage a unified view of the subjects being studied. Laboratory work of increasing sophistication is provided at Levels 1, 2 and 3 and culminates in research-based projects at Level 4. Students are expected and encouraged to become independent learners as they progress.

18. The tutorial system forms a major avenue for learning and is the basis through which continuous assessment is carried out. Considerable care is taken in producing the relevant problem sheets which contribute 20 per cent of the final module mark. These are marked thoroughly and the feedback to the students provides an excellent means of monitoring progress and of facilitating learning.

19. The laboratory teaching is appropriately organised to develop within students a capability for independent research. The controlled and prescriptive approach at Level 1 engenders familiarity with equipment and with error analysis. As students proceed through their degrees, laboratory work becomes more challenging and the projects more open-ended. The staffing of laboratories, which are run by a module leader assisted by at least one other member of the academic staff and a trained postgraduate demonstrator, is entirely satisfactory.

20. The reviewers observed 16 sessions, including lectures, laboratory classes and tutorials. The sessions were generally well planned and supported by well-produced documentation. This included comprehensive notes to support lecture courses and helpful laboratory notes. There were examples of excellent student involvement in tutorials and of well-directed encouragement by tutors. In other cases, however, there was limited use of questioning and missed opportunities for involving students. Lectures were delivered by authoritative staff and were generally appropriately paced, although this was not always the case. Student responses to questionnaires on lectures were generally favourable.

21. The learning environment is highly supportive. The structure of programmes is helped in the first year by the use of a single overarching text, and in later years by comprehensive course notes issued to students. In a few areas, lecturers failed to build upon these sources; in such cases, the students would have benefited from more encouragement to explore and use a wider range of references. The Department is aware of recent methods of curriculum delivery based on information technology (IT), has assessed their contribution and exploits such products effectively in chosen areas, notably in astrophysics and electronics.

22. A positive attempt is made to identify key skills and to develop them through the teaching and learning process. Report writing, poster production, the 'conference' presentation of research results, the generation of grant proposals and other communication skills are taught very satisfactorily. The attainment of skills in information retrieval is hindered by limited library provision, although use of electronic literature surveys is satisfactory. Mathematics forms an important part of the skills module at Level 1, and every effort is made to ensure that students with a wide range of backgrounds are brought up to a similar mathematics standard by Level 2.

23. The reviewers' scrutiny of a large representative sample of students' examination scripts, laboratory reports, dissertations and project reports confirms the very high quality of assessment practices. The range of assessments is well matched to aims and objectives, and assessment criteria are very clearly laid out. There are appropriate processes for the setting and marking of examinations, coursework and projects. External examiners attest to the efficacy of assessment processes.

24. This aspect makes a full contribution to the attainment of the stated objectives. The aims set by the subject provider are met.

Teaching, Learning and Assessment: Grade 4.

Student Progression and Achievement

25. Over the past three years, there has been an average ratio of 6.5 applications for each place. Some 96 per cent of entrants have GCE A-Levels, with an average points score for physics and astrophysics programmes of 17.8 and 21.7 respectively. Of the intake, 14 per cent are women and 15 per cent mature students.

26. Until 1997, the progression rate from Level 1 to Level 2 physics had been constant at about 50 per cent of the intake. Much of the shortfall was attributable to students transferring to other principal subjects, which is an essential feature of the Keele system. On the other hand, transfers into physics have been rare because of the prerequisites of the subject. Overall progression has been satisfactory, with over 70 per cent of entrants progressing to an honours degree, within the University's dual honours system. However, there were strong indications that because of changes to the physics GCE A-Level curricula and the variation between different examination boards, the knowledge and skills of a significant number of entrants no longer matched the first-year modules, particularly in mathematics. The Department therefore decided to modify both the content and delivery of its first-year modules, with the result that the progression rate within physics increased to 80 per cent for the 1998 cohort. Early indications for the 1999 cohort also suggest increased retention within the subject. There have been few withdrawals after the first year.

27. Students who graduate achieve an appropriate range of honours. In the three years from 1996 to 1999, 24 per cent of graduates were awarded First class

honours degrees, 22 per cent Upper Second class honours, and 34 per cent Lower Second class honours. External examiners have soundly endorsed the standard of achievement. All successful graduates automatically qualify for graduate status of the Institute of Physics.

28. The reviewers scrutinised a wide range of students' written work and also observed laboratory work and students' oral presentations. The work seen was of appropriate quality and demonstrated that students had acquired appropriate transferable and subject-specific skills, thereby fully meeting the course aims.

29. The employment record of the graduates is very good. The skills and knowledge that they bring to the workplace are much valued by employers, and over the past three years the majority of graduates have either found employment in technically-based industry or government establishments, or have proceeded to further study at MSc or PhD level. A small number have secured positions in finance and teaching.

30. This aspect makes a full contribution to the attainment of the stated objectives. The aims set by the subject provider are met.

Student Progression and Achievement: Grade 4.

Student Support and Guidance

31. Students of physics enjoy a very supportive and purposeful working environment. A highly effective personal tutor system combines well with an efficient and accessible student office, which is a model of good practice. This arrangement, coupled with close liaison with the centralised support services, ensures that appropriate and timely support is available to students. Staff take good advantage of the relatively small scale of the provision to get to know the students well and to operate a genuine open-door policy which provides students with easy access to all staff, including the Director of Studies.

32. There are appropriate admissions and induction arrangements which are well supported by extensive documentation. Prospective students are sent copies of the university prospectus and detailed course literature, and are also directed to the departmental website. In addition, they are invited to attend open days and other events, such as specialist topic workshops aimed at local schools. This valuable outreach initiative has raised the Department's profile in the local community and has increased recruitment.

33. Before enrolment, all new students are required to complete a pre-University physics profile which provides staff with valuable information about the students' backgrounds. It specifically identifies those who might have difficulties with the more mathematical topics, so that extra tutorials can be arranged. All new students attend the University's three-day induction course and in addition have a day-long introduction to the physics discipline. During this latter event, they are welcomed in an informal setting, meet key members of staff and are made aware of major facilities, including the operation of the student office. During their first laboratory period, they are also introduced to aspects of health and safety, and these are consolidated as students progress through the courses.

34. All first-year students are provided with a university student handbook and a school handbook. These provide full information about the content of courses, administration, structure, operation and examination/progression regulations. Both handbooks also contain details about central services, both pastoral and academic, and the resources, particularly in respect to study skills, provided by the learning support unit.

35. Student performance and progression are monitored by one of four teaching committees, which meet regularly so that any problems of specific students can be readily identified and addressed. Student attendance is also checked at these meetings and, if necessary, appropriate action taken. Communication between staff and students through email is strongly encouraged.

36. In addition to the personal tutorial system, students receive support and guidance from all staff involved in delivering the courses, and the open-door policy is used and much appreciated by students. The School has fully implemented the University's policy for students with special needs. Students are well briefed in the second year about the content of specialist final-year options to help them to choose in line with their specific academic requirements.

37. The University's careers service provides a session for second-year students to introduce them to available facilities and follows this up with focused sessions in the final year. It organises many central events, and 'drop-in' or course-specific sessions are arranged in the Department. Guidance is also available on job application and the writing of curricula vitae. Such provision complements the exercises organised in the Department within second-year skills sessions. A departmental staff member, acting as the link with the careers service, publicises careers events and makes students aware of, and encourages them to use, the central facilities. For students who wish to spend a period abroad, the international office makes the necessary arrangements and briefs the students before their departure.

38. This aspect makes a full contribution to the attainment of the stated objectives. The aims set by the subject provider are met.

Student Support and Guidance:
Grade 4.

Learning Resources

39. The Department has a clearly stated strategy that seeks to match learning resources to the curriculum. The Learning Resources Committee is energetic in pursuing this strategy. It meets regularly, is comprehensive in its discussions and liaises effectively with the relevant areas of the University.

40. The University has a formula-based system for allocating equipment budgets that has led to continuing reductions in the physics teaching equipment budget over several years. At present, the equipment available for laboratory work in physics is variable in quality. In some cases, the equipment is new and readily available, for example in electronics and optics, but in other areas, notably in relation to physics projects, the equipment is dated and limited in range. This limits the students' exposure to contemporary experimental practice, their choices of attractive experimental projects and their familiarity with a range of experimental equipment. These shortcomings are in part mitigated by first-rate support from both academic and technical staff who provide individually tailored guidance to students across the range of practical activities. This support is highly valued by students.

41. The Department has excellent observatory facilities and is able to access large and valuable astrophysics data archives. These resources are exploited effectively to provide a rich learning environment for relevant astrophysics modules. Other students benefit, on an ad hoc basis, from access to national research facilities gained through project supervisors with relevant research interests.

42. Library facilities are concentrated in a central university library within which there are extensive computing facilities. The library has long opening hours. The funding of the physics collection in the library has proved insufficient over several years to maintain the journal subscriptions and refresh both core course texts and the wider text collection. Although recent targeted funding has helped to ameliorate the situation and electronic journals are becoming available, there remains a limited range of non-course texts. This adversely affects the students' ability to develop the information retrieval skills that are highly valued in graduates. Within the library, there is well-designed user documentation, adequate user support and appropriate induction training.

43. General-purpose IT equipment is available centrally on the campus and within the Department. These resources are sufficient to cope with current student needs. The University is reacting energetically to increasing demand by expansion of the network to halls of residence. There are active plans for networking the 3,200 student rooms.

44. Overall, teaching accommodation is fit for purpose. Lecture, seminar and tutorial facilities are generally of appropriate size and properly maintained, although there is some evidence of localised minor difficulties. Laboratories are similarly of good quality and sufficiently large to provide good circulation space. There is adequate appropriate space for personal study in the library and the Department. The on-site residential and social accommodation is valued by students and helps to create a strong campus community that is a distinctive feature of the University. Students are generally able to spend at least two years in campus accommodation.

45. This aspect makes a substantial contribution to the attainment of the stated objectives; however, there is scope for improvement. The aims set by the subject provider are substantially met.

Learning Resources:
Grade 3.

Quality Management and Enhancement

46. There are appropriate mechanisms for the monitoring of quality. Key roles are played by the four teaching committees, covering physics, astrophysics, subsidiary subjects and physics for biomedical sciences and physiotherapy. These meet every three weeks and are responsible for the content, structure and organisation of the undergraduate degree programmes, as well as the laboratory programme and lecture allocation. The annual course review provides a self-critical analysis of the provision and there is significant evidence of a long-term concern with the quality of the provision.

47. The University's rigorous internal quality audit process monitors the mechanisms and procedures which departments have in place for assuring the quality of teaching and learning within programmes. An audit of the Department of Physics was conducted in May 1997 and the report of this audit provided an extremely valuable and thorough review of the progress the Department had made in achieving the aims and objectives relevant to the six aspects of provision. This self-critical and constructive analysis was reflected in the self-assessment, which, alongside the internal audit report, provided a very sound basis for the subject review visit.

48. Students have a range of appropriate mechanisms through which they can make their views known. Staff-student liaison committees provide a forum for student input into the monitoring and development of programmes. In discussion with the reviewers, students indicated that their views are taken into consideration. In addition, student feedback on the operation of individual modules is gathered through questionnaires, the results of which are discussed at review meetings. Such input has often resulted in the modification of the content and operation of specific modules.

49. External examiners play an important role in the development of courses and processes. Their reports have been very supportive of the provision, and any suggestions have been given careful consideration and acted upon where relevant.

50. Appropriate provision is made for the induction of new staff. They attend a Teaching and Learning in Higher Education Programme. They also have a departmental mentor to help them during their probationary period.

51. Whilst review of provision has been thorough and has led to appropriate responses when the need for change has been identified, the approach has been reactive rather than pro-active. This was demonstrated in modifications to the curriculum which were made after significant numbers of students were seen to move out of physics to other subjects over several years. It has also been seen in staff development activity, which has often been undertaken in response to perceived difficulties rather than as a pro-active approach to disseminating good practice. There is a process of peer review of teaching which, along with formal appraisal, has identified specific problems, and appropriate action has followed. However, there has been little activity aimed at bringing fresh ideas into the School from outside or of disseminating best practice internally. As a result, weaknesses seen in some observed classes are not being addressed forcefully.

52. This aspect makes a substantial contribution to the attainment of the stated objectives; however, there is scope for improvement. The aims set by the subject provider are substantially met.

Quality Management and Enhancement: Grade 3.

Conclusions

53. The quality of education in physics and astronomy at the University of Keele is approved. All aspects make at least a substantial contribution to the attainment of the stated objectives and the aims are at least substantially met. The reviewers come to this conclusion, based on the review visit together with an analysis of the self-assessment and additional data provided.

54. The positive features of the education in physics and astronomy in relation to the aspects of provision include the following:

a. The demanding and rigorous curricula which provide programmes whose level, breadth and depth are well matched to aims and objectives (paragraphs 9 to 12).

b. Curricula which develop appropriate subject-specific and transferable skills, and which are informed by the research and scholarly activity of staff (paragraphs 13; 15).

c. Rigorous and well-considered assessment processes, including the provision of constructive and timely feedback (paragraphs 18; 23).

d. The valuable contribution that laboratory sessions make to student learning (paragraph 19).

e. The good quality of achievement by successful students and their progression to appropriate employment (paragraphs 27 to 29).

f. The excellent quality of student support and guidance, provided by academic and support staff within the physics discipline (paragraphs 31; 35; 36).

g. Excellent observatory and other facilities to support astrophysics provision (paragraph 41).

h. A rigorous self-critical approach to quality monitoring and review (paragraphs 46 to 49).

55. The quality of education in physics and astronomy could be improved by addressing the following issues:

a. Shortcomings in library resources and some laboratory facilities (paragraphs 22; 40; 42).

b. The lack of a pro-active approach to quality enhancement in areas such as curriculum and staff development (paragraph 51).