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TEACHER CONTENT KNOWLEDGE STUDY

An Assessment of the Class 5 Content Knowledge in

Math, Science and Urdu

of PTC Students and Primary Teachers

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DIRECTORATE OF PRIMARY EDUCATION

TEACHER CONTENT KNOWLEDGE STUDY

EXECUTIVE SUMMARY

BACKGROUND

Introduction and study purposes

A thorough knowledge of the content to be taught is essential for effective teaching. Critics say a serious obstacle to improving the quality of children's learning at the primary level is the limited knowledge of subject content that many teachers bring to the classroom.

This study aimed at assessing the knowledge of subject content taught in class 5 of primary school of Primary Teaching Certificate (PTC) students studying in Government Colleges for Elementary Teachers (GCETs), and inservice teachers, in order to make recommendations for preservice as well as inservice training.

The specific objectives of the study were:

- To assess the strengths and weaknesses in the class 5 content knowledge in math, science and Urdu, of teaching candidates entering PTC training in GCETs;
- To assess the extent to which the present PTC training in the GCETs provides teachers with class 5 subject content knowledge in math, science and Urdu;
- To recommend supplementary PTC training in math, science and Urdu for the GCETs based on identified weaknesses in teachers' knowledge;
- To test whether candidates to GCETs with higher academic qualifications perform better on class 5 achievement tests than those with lower qualifications;
- To assess the strengths and weaknesses in the class 5 subject content knowledge in math, science and Urdu of working teachers with varying years of experience;
- To recommend refresher training in math, science and Urdu to compensate for identified weaknesses in inservice primary teachers' class 5 content knowledge;

About 900 PTC and CT students in six GCETs, (three male and three female colleges), were tested with the use of PEP-II class 5

curriculum based achievement tests in math, science, and Urdu. The students took the tests at the **beginning** and at the **end** of the course. About 600 primary teachers from a representative sample of 184 primary schools at six sites were tested (three male, and three female sites, in a total of four districts).

CONCLUSIONS

I. Preservice Teachers (PTC students)

PTC students' entry levels: PTC students at the beginning of their training obtained low results on the math and science tests, indicative of serious weaknesses in class 5 content knowledge for these subjects. For Urdu the average is much higher, but the majority of students still do not have the full mastery needed to teach all primary school levels. The PTC training therefore, needs to address considerable class 5 content areas, as well as those of other class levels.

PTC training: The PTC training may have had effect on achievement in math. However, the PTC training did not have a major effect on students' class 5 content knowledge, needed to bring them from their entry levels to full mastery of primary class 5 content. It appears therefore, that the PTC training either does not address class 5 content knowledge, or does not do this effectively. The training leaves PTC students ill-prepared to teach the content of math and science in particular.

Math: The most serious weakness in PTC students' knowledge base is in math. Though PTC training has had the largest impact on math scores, it has not addressed the severe deficiencies. Only a relatively small percentage of PTC students obtained a fairly high score. Most PTC students scored in the middle range, and would probably need substantial revision of class 5 math material. Another large low scoring group, would need a major revision of primary math material.

Science: PTC training has made no difference for performance on the science test. Only around 10 percent of the students obtained a reasonably high score. Most students scored in the middle range. The latter will have difficulty teaching much of class 5 science, and therefore need training that substantially revises this material.

Urdu: The average content knowledge of teacher trainees in Urdu is reasonably good. The PTC training may have made a small difference for performance on the Urdu test, however, results were already high before the training. However, there is still a sizeable group of students which did not achieve a high enough score for mastery. These deficiencies do not seem to be addressed effectively in the PTC training.

Academic qualifications: The level of academic qualifications proved to be a good predictor for the students' achievement on tests of all three subjects. Achievement on the tests increased with increasing years of academic schooling for all subjects. Academic background makes the largest difference for math. Stream proved a good predictor for achievement on math and science. Students with a science stream background scored higher on math and science than their peers with equal numbers of years of academic training but an arts background. The large majority of science students are male.

Colleges: The differences at the beginning of the PTC course of student bodies in different training colleges are larger than the differences at the end of the course. The PTC training may have some equalizing effect on the test scores, but the training does not on average bring students to the same end levels. Most important, no single college manages to bring an acceptable proportion of students to acceptable levels of content knowledge in math or science. Performance on math and science of PTC students in colleges with a less good academic reputation proved considerably lower than in other colleges.

Gender: On average, female students scored about the same as male students on science and Urdu. Male students obtained a better average on math. When controlling for academic background, female students consistently outperformed male students in science and Urdu. When controlling for academic qualifications and stream, female Matric students also scored higher on math than male Matric students. This seems to indicate that female students may, on average, be better students than male students with equal qualifications.

However, as a group female PTC students are less qualified than their male peers. 35 percent of female students has more than a Matric, as compared to more than 60 percent of male students. Also, about half of the male students have a science background, against less than 10 percent of the female students.

II. Inservice teachers

Content knowledge base: Inservice teachers obtained low results on the math and science tests, indicative of serious weaknesses in class 5 content knowledge for these subjects. For Urdu the average is much higher, but a large proportion of primary teachers still does not master class 5 Urdu content fully.

Math: The most serious weakness in inservice teachers' content knowledge is in math. Only a relatively small percentage of primary teachers obtained fairly high scores. More than half of the teachers scored in the middle range. About one third of the teachers scored lower than 50%. These teachers will probably not be able to teach most of the class 5 content.

Science: Results also indicated serious weaknesses in class 5 science knowledge. Only around 10 percent of the students obtained a fairly high score, and most teachers scored in the middle range.

Urdu: The content knowledge of teachers seems reasonably good, though a sizeable group of teachers still did not achieve a high enough score for mastery.

Teaching experience: Length of service makes a difference for math and science, but not for Urdu. Also, teachers who have taught class 5 score better on math and science than teachers who have never taught class 5. Teachers who at the time of the test taught class 5 obtained the highest scores on the science and math test. However, differences are so small, that not even the class 5 teachers have obtained mastery in these subjects. This means that in their work they have to teach content they do not know themselves. The fact that there are no meaningful differences between the average scores of PTC students (at the end of the training) and inservice teachers, indicates that inservice teachers do not learn any more content in the course of their work.

Academic qualifications: Also inservice teachers' achievement increased with their years of academic schooling for math and science, but not for Urdu. Stream proved a good predictor for math and science scores for teachers with a Matric. There were however, too few teachers with FSc and BSc backgrounds in the sample to compare them with FA and BA holders.

There are no real differences in achievement between trained and untrained teachers, and between trained teachers with PTC certificates from different sources (a regular GCET, AIOU, condensed course). Only teachers with a CT or BEd obtained higher results on math. However, the differences are too small to be educationally meaningful.

III Knowledge/skill areas: The content in the PTC curriculum does not relate to, except perhaps in very limited subject areas, the content of class 5 textbooks. If it does, the PTC content is not explicit enough to remove deficiencies. The PTC training can therefore be considered as not appropriate to the needs of primary teaching. The inservice teachers have approximately the same scores as PTC students on the posttest in different knowledge/skill areas, which indicates that primary teachers have not learnt any specific content areas after leaving the GCETs.

In **math** and **science** performance of PTC students and inservice teachers on none of the knowledge/skill areas represented in the test was very high. All primary curriculum math and science content will need to be addressed through training to raise PTC students' and inservice teachers' content knowledge to acceptable

levels. For **Urdu** most PTC students and inservice teachers show near mastery on most of the knowledge/skill areas in the test, with the exception of grammar. In Urdu, emphasis of training does not need to be on content knowledge, but should emphasize methods of teaching language to children.

RECOMMENDATIONS

I. Remedial Training

The majority of primary teachers and PTC students do not have the thorough knowledge of class 5 subject content in math and science, and they probably do not have the knowledge of lower class math and science content and other subjects, which they need to teach the primary curriculum successfully.

To enhance the content knowledge of primary teachers and improve the quality of teaching in the schools;

- Remedial training in content areas needs to be developed for primary teachers;
- Working teachers should be taught in short inservice training courses;
- The PTC training should tackle the problem with teaching candidates before they enter the profession, through improved content courses;
- Such training should be organized around the existing primary texts and instructional materials;
- Increasing content knowledge of teachers as well as instructing teachers/PTC students in teaching methods should be the dual focus of such training, to ensure primary teachers do not just learn content, but also learn how to teach the content;
- The Curriculum Bureau/Education Extension staff in collaboration with Directorate of Primary Education staff should develop an action plan to address the problem, including setting of objectives, standards of success, a workplan (all steps to be taken, and who will be responsible for each action), time schedule, budget and evaluation plan;
- One particular aspect to define would be linkages between inservice and preservice courses, to avoid duplication of s effort, and ensure that training for preservice is closely tied to the realities PTC students will encounter as teachers;

- An important aspect regarding preservice remedial training is the place of such training in the PTC course. It is recommended that the new courses eventually replace or partially replace the present content courses in the PTC curriculum. The new courses will need to achieve the objectives set at the federal level for the PTC content courses.

II. Admission policies

The study showed that the PTC students with higher qualifications obtained better scores on all three subjects. Therefore:

- The present GCET admission policy of giving preference to candidates with higher qualifications before considering candidates with lower qualifications should continue;

- Science students should be given preference over arts students, to obtain candidates with better content knowledge in math and science;

- At the same time, admission policies should serve as general guidelines only. Other factors will need to be considered, for example for specific geographical areas for which it is difficult to find teachers. There the system may be better served by hiring less qualified teachers who are from the area, and by compensating for weaknesses in their content knowledge base through remedial training during the PTC course. This applies in particular to the admission of female students.

1. BACKGROUND AND PURPOSE OF THE STUDY

1.1 Background

Education plans for NWFP call for significantly improving the quality of children's learning at the primary level over the next ten years. Critics say a serious obstacle to realizing this aim is the limited knowledge of subject content that many teachers bring to the classroom. Observers of practicing teachers often note mistakes in factual accuracy, answers to problems, conceptualization, grammar, pronunciation, etc. A thorough knowledge of the content to be taught is essential for effective teaching. Much time in teacher training courses is devoted to teaching subject content. In fact, the Curriculum Wing in Islamabad prescribes that half of the preservice PTC training should be devoted to teaching content knowledge. It is unclear however, whether this training actually improves the content knowledge required of teachers at the primary level or, indeed, if it is needed at all. Often this training covers subject content of a much more complicated nature than is necessary for teaching primary grades.

A BRIDGES study of 500 schools found higher achievement scores among students of class 4 and 5 in math and science whose teachers had completed longer periods of academic training. Professional teacher training made no difference in achievement scores of students. A question which arises from this research is whether longer academic training adds to the content knowledge of teachers, thereby making them better teachers.

It is also possible that experienced teachers, over time, absorb subject content as they teach their classes, using primary school textbooks and other sources as their means of instruction. On the other hand, they may simply refrain from teaching content matter they find difficult. In many schools, teachers move up the class levels as they become more senior, so that the most senior teacher in the school teaches class five. As a result, over the course of their careers, many teachers may be required to teach all of the class levels. They may, therefore, need to understand and teach subject matter up to the fifth class.

As one way to determine whether teachers are prepared in training courses with the subject content knowledge they need, the present study aims to assess their entering and exiting knowledge of subject content taught in class 5 of primary school. To learn more about the content knowledge of inservice teachers, the study assesses their capacities with fifth class material as well. The results should make clearer what specific additional training is required beyond what is currently provided, preservice as well as inservice.

1.2 Purpose of the Study

The overall goal of the teacher content knowledge study is to contribute to improved efficiency and effectiveness of primary school instruction.

The specific study objectives are as follows:

- To assess the strengths and weaknesses in the class 5 subject content knowledge in math, science and Urdu, of teaching candidates entering Primary Teaching Certificate (PTC) training in Government Colleges for Elementary Teachers (GCET);
- To assess the extent to which the present PTC training in the GCETs provides teachers with class 5 subject content knowledge in math, science and Urdu;
- To recommend supplementary PTC training in math, science and Urdu for the GCETs based on identified weaknesses in teachers' knowledge base;
- To test whether candidates to GCETs with higher academic qualifications (FA/FSc) perform better on class 5 achievement tests than those with lower qualifications;
- To assess the strengths and weaknesses in the class 5 subject content knowledge in math, science and Urdu of working teachers with varying years of experience;
- To recommend refresher training in math, science and Urdu to compensate for identified weaknesses in inservice primary teachers' class 5 content knowledge base;

1.3 Assumptions

The success of the present study is based on the validity of three assumptions:

- though primary teachers teach a variety of subject matter, an adequate sample of content knowledge is obtained by testing teacher content knowledge in math, Urdu and science;
- that achievement tests based mainly on what is learned in class five textbooks are satisfactory indicators of the minimum a teacher needs to know to teach the primary classes;
- that already existing PEP - II curriculum based achievement tests which have been tested and revised are an acceptable measure of class five content knowledge.

1.4 Methodology

Sample selection:

1. Preservice teachers: The study was carried out in six GCETs in NWFP, 3 male and 3 female. Out of a total of 18 GCETs (6 for women, 12 for men) in NWFP, this means that one third of the colleges were represented in the sample (half of the female colleges, and a quarter of male colleges). Two colleges (of each category of male and female) were reputed to be of good quality, two of less good quality, the last two served as control colleges. It is assumed that this sample of colleges is representative for all the colleges in NWFP.

To examine the question of whether longer academic training adds to the subject content knowledge of teachers, not only all PTC students but also all Certificate of Teaching (CT) candidates - who have on average higher qualifications than PTC students - studying at the selected GCETs were given the achievement tests to see if they scored better than the PTC candidates. All GCET students were tested at two points in time; in October 1991 at the **beginning** of the teacher training course (pretest), and in April 1992, at the **end** of the course, before the start of the practice teaching period (posttest).

A total of 769 PTC students (327 female, 442 male) and 137 CT students (123 female, 114 male) took the pretest, and 728 PTC students (316 female, 412 male) and 160 CT students (116 female, 44 male) sat for the posttest. Different factors contribute to the differences between the pretest and posttest numbers. First of all, at both times that the test was conducted a number of students was absent at each GCET. At one GCET CT students were absent from the GCET for practice teaching at the time of the posttest.

2. In-service teachers: A sample of primary teachers at six sites were tested (six sites in four districts: in two districts male as well as female teachers were tested, in one district only male, and in the last only female teachers). Four sites where IMDC Kachi materials were introduced and evaluated were selected. This was done so that additional teacher information could be obtained that would potentially be useful for the ongoing introduction of new instructional materials. In addition two other sites were selected. For each site the minimum number of teachers invited for the test was set at 100.

At the four 'IMDC' sites, all teachers from the schools involved with the IMDC Kachi material evaluation were tested (also when the number at a site exceeded 100). IMDC schools had been randomly selected from lists of primary schools within a 10 km radius of the SDEOs offices. The same procedure was followed to select schools at one other site, as well as for one IMDC site,

where the number of teachers involved in the Kachi materials evaluation was less than 100, to select additional schools. At the last site, the education officials had asked the headteachers from 45 schools within the 10 km radius to send 2 or 3 teachers for the test. Thus, a total of 738 primary teachers from 184 primary schools were invited (425 male, and 313 female teachers), and out of those 628 teachers appeared for the test (329 male, and 299 female teachers). This sample can be considered to be representative for all primary teachers in NWFP. If anything, one would expect the overall test results to be lower, not better, since it is the teachers of the more rural and far-flung areas that were not covered in the sample. The inservice teachers were tested in May 1992.

Test instrument: Achievement tests based on the class 5 curriculum in math, science, and Urdu, developed by the World Bank funded Second Primary Education Project (PEP-II) were used. These tests were developed to test academic achievement of class 5 primary school students. The math and science tests consisted of 50 test items each, the Urdu test consisted of 40 items (the listening comprehension section comprising 10 questions was not used). Each test included a mix of multiple choice items with 4 options and open-ended items. Cover sheets were provided to collect basic information about PTC students and inservice teachers (see Annex 1 for a translation of the tests).

Test procedures: For both the pretest as well as the posttest in the GCETs Directorate of Education staff assisted by staff of the PED Technical Assistance Team conducted the tests in the GCETs. Some GCETs had space available to accommodate all students in one room, in other GCETs students were tested in their classrooms or were seated outside. GCET faculty acted as invigilators.

For testing inservice teachers a senior official of the Directorate of Education was in charge of testing male teachers, a female PED consultant for testing female teachers. Both were assisted by DPE district and subdivisional staff. Tests were held in schools or other large buildings. In some cases all students sat together in one hall, in others they took the test in separate classrooms. In some sites they sat on the floor, in other sites they had desks and chairs. ASDEOs and LCs acted as invigilators.

All invigilators were briefed about the purpose of the test and the test procedures beforehand. Students and primary teachers also received a short explanation about the purpose and structure of the test, an explanation about how to complete the cover sheet with basic information, and how to answer multiple choice questions.

Data processing: Teachers in Abbottabad under the supervision of a senior DPE officer corrected the open-ended questions and

transferred the scores onto a scoring sheet for each individual GCET student or primary teacher. The data were then entered into a RBase programme at the EMIS Cell of the Directorate of Primary Education, and RBase and SPSS software were used to analyze the data.

1.5 Limitations of the study design

There are a number of limitations to the study design which have to be taken into account when interpreting the results.

- Test effect: In the GCETs the same students took the same test twice. It can be assumed that they will do somewhat better on the second test because it is a second exposure. However, the improvement coming from a second exposure is likely to be small, as the time between the exposures was at least 6 months.

- Test coverage: The tests were not designed for the purpose of this study. As is apparent from the item analysis section of this report (see para 2.3), the tests are not balanced in terms of coverage of skills and knowledge in the three subjects under study. For example, the math test contains 14 geometry items, only one long division item and no addition or subtraction items. This limits the scope for identifying all training needs relevant to primary curriculum content.

- Significance: A simple comparison between posttest and pretest results can be made, which for the purpose of the study can be considered adequate. However, a test for statistically significant differences between pretest and posttest scores which would have given stronger evidence could not be made, because it proved not to be possible to match individual students.

2 FINDINGS

2.1 Pre-service teachers

2.1.1 Entry content knowledge level

This section examines the entering knowledge of PTC students, measured at the beginning of the PTC training. How much of the content of class 5 material do the PTC students know when they enter the GCETs? Knowledge of the entry levels of PTC students will roughly indicate how much the regular PTC training, or supplementary remedial training, will need to accomplish with the students that enter at the beginning of the year.

The following are the main pretest results on the achievement tests.1)

Mathematics: The 50 item math test was taken by 736 PTC students in the six teacher training colleges.

- The average score was 51 percent correct responses;
- Male students on average obtained a higher score (54.6%) than female students (46.2%);
- Just over half of PTC students (more than 45% of male and 60% of female students) obtained a score lower than 50 percent (25 out of 50 test items);
- Roughly half of the male, and over 35 percent of the female students scored between 50 and 80 percent correct;
- 6.3 percent of male and 1.6 percent of female students obtained a score higher than 80 percent, which represents a total of 31 students in the six colleges;
- The highest score obtained is 48. This score was obtained by one male student. In the group of female students the highest score was 43, also obtained by one student.

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1) In examinations in government educational institutions in Pakistan the passmark is normally set at 33%. This makes the results on these tests seem high. However, one has to remember that these are class 5 tests, taken by teaching candidates who have at least 10 years of education, and who need full mastery to be able to teach the content covered in the test as teachers.

PTC students appear to have serious deficiencies in class 5 math content knowledge, as evidenced by the average score of 51 percent, and the fact that over half of the students obtained a correct score of less than 50 percent. It is likely that many students also do not know the math content of lower class levels. The GCETs will need to raise the PTC students' knowledge considerably in the course of the teacher training program for them to master the class 5 content.

Science: The 50 item science test was taken by 715 PTC students.

- The average score was 66.2 percent of test items correct;
- There was no significant gender difference in average performance;
- A score of less than 50 percent correct was obtained by 15 percent of male, and 9 pecent of female students;
- About three quarters of male students and just over 80 percent of female students scored between 50 and 80 percent correct;
- Less than 10 percent of PTC students achieved a score of more than 80 percent correct responses;
- The highest score obtained in the group of female students is 45 (2 students) and 47 for male students (1 student).

Deficiencies in science are apparent from the scores obtained. Fewer students obtained a score lower than 50 percent than was the case for math, but the performance of the large majority of PTC students (about 90 percent) is below 80 percent correct. These students probably have major gaps in their class 5 science content knowledge, which the PTC training needs to address.

Urdu: 738 PTC students took the 40 item Urdu test in the six teacher training colleges.

- The average score was 85.5 percent correct responses;
- The average achievement of male and female students approximately the same;
- Roughly one quarter of male students and 17 percent of female students obtained a score lower than 80 percent;
- The majority of PTC students (over 70 percent of male,

and just over 80 percent of female students) achieved a score of more than 80 percent (more than 32 out of 40 items correct);

- One third of male and close to 45 percent of female students scored more than 90 percent correct;
- The highest score obtained was 39, and 8 percent of female and 2 percent of male students obtained this score.

For Urdu results are much better than for math and science, as evidenced by a considerably higher average score, and the fact that about 40 percent of all students obtained a score higher than 90 percent. This still means that the majority of students do not appear to possess all the necessary class 5 content knowledge. They would need to learn this Urdu content in the PTC course. Notable too is that more female students obtained higher scores than male students on the Urdu test.

2.1.2 PTC training

The previous section showed that there are weaknesses in the entering knowledge of PTC students in math and science, and to a lesser extent in Urdu. Half of the instructional time in the GCETs is supposed to be spent on teaching content. This section examines more closely whether and to what extent the PTC training made a difference in the class 5 content knowledge levels of PTC students, by comparing pretest and posttest scores.

Differences in colleges are also examined in this section. A BRIDGES study of effective teaching practices in primary schools in Pakistan found that teachers in primary schools that were considered 'good' schools by supervisors, also produced higher achievement in their students on academic tests than teachers in 'less good' schools. A question that is raised is whether some GCETs do a better job than others in preparing their students to become primary teachers. Of course this question is examined only in so far as related to class 5 primary content knowledge.

Table 1: Gains in average scores (in percent), PTC students

subject	Pretest (1) av. in %	Posttest (2) av. in %	Gain (2 - 1) in % points
Math	51.0	58.2	7.2
Science	66.2	67.8	1.6
Urdu	85.5	88.5	3.0

Table 1 juxtaposes entering (pretest) and exiting (posttest) results. The table shows that the average score increased in all three subjects. However, the gains in scores for science and Urdu are small. It is possible that these differences have occurred by chance, or because this was a second exposure to the test.

Only in math there is a more considerable gain in scores, of 7.2 percent (equivalent to an increase in scores of 3.6 test items). 2) There are some notable gender differences. On the math test, the female PTC students gained the most, 10.0 percent, as compared to a gain of 5.0 percent for the male students. Male students gained more on the Urdu test, 4.3 percent as compared to 1.3 percent for the female students. At the end of the training, there are no clear differences between the average scores of male and female students.

The average posttest scores on math and science indicate that the average exiting levels of class 5 are still insufficient to teach a considerable amount of that content. Many but not all PTC students master the class 5 Urdu content knowledge. The limited gains that occurred in all subjects indicate that the training did not have a major effect in bringing students from their entry level knowledge to full mastery of class 5 content.

Table 2 examines changes in the distribution pattern of scores, for three score groups:
1) between 0 and 50 percent correct, 2) between 50 and 80 percent correct, 3) between 80 and 100 percent correct. It is unlikely that students who score less than 50 percent of the items correct, will be able to teach the subject content to any reasonable extent. Students who score between 50 and 80 percent will perhaps have sufficient knowledge to teach some, but not all the content. Students scoring above 80 percent may have the knowledge base to teach most, but not all the class 5 content.

Table 2: Distribution of scores in % for pretest and posttest

score in %	Math		Science		Urdu	
	pretest	posttest	pretest	posttest	pretest	posttest
0-50	52.9	34.5	12.5	10.5	2.6	0.5
51-80	42.9	56.0	78.3	78.1	22.1	16.0
81-100	4.2	9.5	9.2	11.4	75.3	83.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

2) It was not possible to match pretest scores of individual students with posttest scoreas. Therefore, a t-test for matched groups to establish the strength of the differences at statistical significance levels, could not be carried out.

- **Math:** The table shows that there are clear improvements in math only. For example, while on the pretest more than half of all PTC students in the six colleges obtained a score of less than 50 percent correct responses, this has dropped to just over one third of all students. For the female students the improvements are the most dramatic. For example, while just over 60 percent of female students scored less than 50% correct on the pretest, this is 35 percent on the posttest (for male students the figures are just over 45% and 34% respectively). It appears that PTC training reduces some of the deficiencies in class 5 math content knowledge with which PTC students enter the GCETs.

  However, the PTC training did not have sufficient impact on math scores to remove the most severe deficiencies, or to raise students' content knowledge to mastery. Math, in fact, remains the weakest subject, with about one third of all students scoring less than 50 percent of the items correct at the end of the PTC training.

- **Science:** In science, improvements are small, if not negligible. There are no notable gender differences. Overall, PTC training did not have any meaningful impact on the class 5 science knowledge of the students.

  Science remains the second weakest subject, with the large majority of students obtaining a score lower than 80%. This means that there is considerable science content PTC graduates do not know, and will be unable to teach.

- **Urdu:** In Urdu, there is some improvement. Male students show most differences in scores between pretest and posttest, the differences for female students are only small. Almost 45 percent of all PTC students obtained a score between 91 and 100 percent, which was just over 38 percent for the pretest. Overall, it appears that the PTC training does make some, albeit a small, difference in class 5 level content knowledge in Urdu.

  For Urdu, the scores were already better than for the other two subjects at the beginning of the PTC training. However, the PTC training does not raise students to full mastery either. There is still a group scoring less than 80 percent correct at the end of the training, and more than half of the students score less than 90 percent correct.

Colleges: The next table shows the scores for different colleges. To begin with, there were differences in average **entering** knowledge between the student populations of colleges. The students of the colleges which are considered academically less good institutions (college number 2 and 5) had the lowest average entering knowledge in all subjects.

Table 3: Gains in average scores (in percent) by GCET between pretest and posttest for PTC students

GCET	Math pret. av. (a)	Math postt. av. (b)	Math gain (b - a)	Science pret. av. (a)	Science postt. av. (b)	Science gain (b - a)	Urdu pret. av. (a)	Urdu postt. av. (b)	Urdu gain (b - a)
1 (F)o	47.6	57.8	10.2	68.8	70.2	1.4	93.0	90.5	(2.5)
2 (F)*	38.8	51.4	12.6	54.4	66.0	11.6	79.8	86.5	6.7
3 (F)+	50.4	58.6	8.2	68.6	68.6	0	84.5	88.0	3.5
4 (M)o	64.8	67.8	3.0	69.2	70.8	1.6	85.2	88.7	3.5
5 (M)*	47.6	55.0	7.4	59.4	63.6	4.2	84.2	86.5	5.0
6 (M)+	51.2	55.2	4.0	65.8	65.8	0	84.2	89.2	5.0
Total	51.0	58.2	7.2	66.2	67.8	1.6	85.5	88.5	3.0

o control colleges; * colleges with less good academic reputation; + colleges with a good academic reputation

In terms of increasing PTC students' level of class 5 content knowledge, the PTC training appears to have made some difference in math in all colleges. For science, meaningful gains were only achieved in college 2 and 5. For Urdu, there are small gains in all colleges, except college 1. The table shows that the largest gains in all subjects are made in college 2, which is the college with a less good academic reputation. Even so, this college continues to have the lowest exiting levels.

It is hard to surmise the reasons for the differences between the college scores and the gains that were achieved. For example, are there such large gains in college 2 because the quality of instruction is high, or because students with low levels of entering knowledge stand to benefit more from the PTC training than students with relatively stronger academic backgrounds? There are fewer differences between colleges in exiting than in entering knowledge for all subjects, which could be the result of the PTC training. However, the PTC training does not bring students to the same end levels. Most important however, is that no single college manages to bring acceptable proportions of students to acceptable levels of math and science class 5 content knowledge. For Urdu also, the PTC training does not raise achievement enough to bring all students to mastery.

2.1.3 Academic background

One of the specific study objectives was to test whether candidates to GCETs with higher academic qualifications perform better on the class 5 achievement tests than those with lower qualifications. To find out whether indeed longer academic

training adds to the content knowledge of teachers, CT students who possess on average higher academic qualifications than PTC students were also evaluated in the selected GCETs.

It was found that more male PTC students have high qualifications than female PTC students. Almost 40 percent of male PTC students completed an FA/FSc degree and some 13 percent a BA/BSc, while only about 16 percent of the female PTC students have an FA/FSc degree and 7 percent a BA/BSc degree. The remainder (more than 65 percent of female, and less than 40 percent of PTC students) are Matriculates (Matric is the minimum entry qualification for PTC training).

At the Matric level, students choose to study in either the arts or science stream. After Matric, streaming continues, with students either studying for an FA (Faculty of Arts), or a FSc (Faculty of Science). It was found that male PTC students more often have a science stream background. Beyond Matric almost all female students have completed an FA or BA degree, while amongst the male students a sizeable proportion has a FSc or BSc degree. While 70 percent of the male Matric students studied in the science stream, 84 percent of the female students had studied in the arts stream. For CT students the pattern is similar, only CT students are on average more highly qualified than the PTC students (FA/FSc is the minimum qualification, as compared to Matric for PTC students).

Table 4 analyses the effect of academic background of PTC/CT students for the pretest data. The table shows that indeed achievement increases with increasing years of academic schooling. Academic background makes the most dramatic difference for math, between Matric and BA/BSc the average score increases by 20.4 percent (all differences in math are statistically significant at the 5% level). The differences for science and Urdu between a Matric and a BA/BSc graduate are 4.6 percent and 3.7 percent respectively.

Table 4: Average pretest scores by academic background and subject (*)

Academic background	Math			Science			Urdu		
	n	av.	%	n	av.	%	n	av.	%
Matric	417	23.7	47.4	431	32.6	65.2	447	33.8	84.5
1st year FA/FSc	109	26.2	52.4	106	34.1	68.2	83	35.1	87.7
FA/FSc complete	240	28.9	57.8	219	34.6	69.2	243	35.1	87.7
BA/BSc complete	136	33.9	67.8	135	34.9	69.8	137	35.3	88.2
Total	902	26.9	53.8	891	33.6	67.2	910	34.5	86.2

(*) for this table only the largest groups by academic background are presented, the smaller ones are not shown

In annex 2 the same pretest information as in table 4 is presented, but disaggregated by gender. For all subjects, average score increased for both male and female students with each next higher level of academic education. For science and Urdu, average scores of female students are somewhat higher than average male scores for each level of academic qualification. For math, male students score higher than female students, except for female FA/FSc students who have a slightly higher average score than male FA/FSc students.

The posttest scores (annex 3) show a similar pattern, with scores increasing with increasing qualifications. For the posttest data, a disaggregation by stream (arts and science) could also be made. The results show that science students obtained higher scores than arts students with comparable qualifications on math and science. This holds true when comparing Matric science with Matric arts students, FA with FSc students, and BA with BSc students. FSc students scored also higher than BA students on the math and science tests (for math these differences are statistically significant at the 0.05 level, but for science this is not the case). Both FSc and BSc groups almost exclusively consist of male students). In Urdu, stream does discriminate.

Female Matric students who studied in the arts or science stream had higher math scores than male students who studied in the same stream. This makes the male Matric arts students the weakest group in math, and the female Matric arts students the second weakest group. Matric arts students make up a 57 percent of the student body in the female colleges included in the study, and 12 percent of PTC students in the male colleges. It is likely that the relatively low averages of the female PTC students in math are due, or largely due, to the fact that female students, more often have lower qualifications and have studied more often in the arts stream than male students.

At the end of the teacher training previous academic qualification remained a strong predictor for achievement on the PEP-II tests. The PTC (and CT) training therefore, did not raise students with varying levels of academic background, to similar end levels. Within levels of academic background, stream is a good predictor for achievement on the math and science tests. Even so, both the entering as well as exiting class 5 level content knowledge of even the PTC students with university degrees is not very high.

2.2 Inservice teachers

This section assesses the strengths and weaknesses of working primary teachers with class 5 material, for varying years of working experience and other factors that may have influenced achievement on the test. To examine whether inservice teachers gain as a result of their working experience in schools, a comparison between the scores of inservice teachers and the PTC students at the end of their teacher training (posttest) is also made in this section.

2.2.1 Main results

The tests were taken by 628 inservice teachers in four districts (three groups of male, and three groups of female teachers).

Mathematics:

- The average score was 59.4 percent correct responses;
- Male primary teachers on average obtained a higher score (63.8%) than female teachers (54.4%);
- About one third of the teachers (40% of female and a quarter of male students) obtained a score lower than 50 percent correct (25 out of 50 items);
- More than half (roughly half of the male, and 60 percent of female teachers) scored between 50 and 80 percent correct;
- Only 1 percent of female teachers (3 teachers) and a quarter of male teachers obtained a score higher than 80 percent, (just over 10 percent of all teachers in the sample);
- The highest score obtained is 49. This score was obtained by 1 male teacher. In the group of female teachers the highest score was 46, which was obtained by 1 teacher.

Judging from the results, the majority of primary teachers must have very serious gaps in class 5 content knowledge, and probably in the content knowledge of lower class levels as well. The teachers who scored less than half of the items correct (and this is one third of all teachers), will not be able to teach most of the class 5 content. In fact, only a quarter of the male, and 1% of the female teachers appear to know most (but this does not mean all) of the class 5 math content.

Science:

- The average score was 65.6 percent of test items correct;
- A score of less than 50 percent correct was obtained by about 15 percent of the teachers;
- About 70 percent of male teachers and just less than 80 percent of female teachers scored between 50 and 80 percent correct (overall just less than 75 percent);
- Roughly 10 percent of primary teachers achieved a score of more than 80 percent correct responses;
- The highest score obtained in the group of male teachers is 47 (1 teacher) and 45 for female teachers (1 teacher).

Also deficiencies in science are apparent from the scores obtained. The large majority of the teachers obtained a score of less than 80 percent correct. It is likely that they do not know considerable amounts of class 5 science content, and will not be able to teach science to primary class 5 students very well. Only 10 percent of the teachers may have the content knowledge needed to teach most (but not necessarily all) class 5 science.

Urdu:

- The average score was 86.2 percent correct responses;
- Over 20 percent of primary teachers obtained a score lower than 80 percent correct responses (less than 32 out of 40 items correct);
- More than one third of primary teachers scored more than 90 percent correct;
- The highest score obtained was 40, and 19 teachers (3%) obtained this maximum score.

The results for Urdu are much better than for the other two subjects. Still, more than 20 percent of the teachers obtained a score less than 80 percent, which indicates that these teachers have problems with primary Urdu content. The majority, scoring between 80 and 90 percent correct, also may still have some problems with some of the Urdu content. About one third of primary teachers probably knows the class 5 Urdu content well.

2.2.2 Teaching experience

Do primary teachers learn subject content over time? If this were the case, primary teachers with more years of teaching experience would obtain better scores than those with less. Also, if teachers make up for their gaps in content knowledge over time, they may score higher than PTC students (who have followed teacher training but do not have teaching experience) on the class 5 tests.

Table 5: Average scores (in %) by years of teaching experience

	Average score (% correct) Math	Science	Urdu
Teaching Experience			
up to 5 years	55.8	64.6	85.7
6 - 10	57.4	65.8	86.0
11 - 15	62.0	66.0	85.7
16 - 20	66.0	67.2	89.0
21 and more	68.2	65.4	86.7
All primary teachers	59.4	65.6	86.2
PTC students (postt.)	58.2	67.2	88.5

Table 5 shows that only for math the average score clearly increases with longer years of teaching experience. However, even the group of most experienced teachers obtained an average math score of only 68.2 percent, which is not high, considering, again, that the test evaluates class 5 material, which the teachers may have to teach themselves. The posttest math score of PTC students, is closest to the average of primary teachers between 6 to 10 years of experience. Perhaps the PTC students had better achievement than beginning teachers, because they are still in a college atmosphere studying academic subjects and sitting for exams. The beginning teachers may well be too overwhelmed by dealing with their classes, to remember much content. For science the average score increased slightly with increasing length of service, but the differences are not statistically significant. Teachers, therefore, do not seem to absorb Urdu or science content over time, and only some additional math content knowledge.

The table further shows that there are no meaningful differences between the overall average scores of PTC students and inservice teachers. Also (this information is not shown in the table) that the proportion of primary teachers scoring below 50 percent, between 50 and 80 percent, and above 80 percent were roughly the same as the proportions of PTC graduates obtaining these scores.

This was the case for all subjects. The only notable difference is in math, where about one quarter of male primary teachers obtained a score above 80 percent, against about 13 percent of male PTC graduates. Overall, this indicates that the present PTC graduates have about the same levels of class 5 content knowledge in math, science and Urdu as inservice teachers. This would mean that primary teachers, over time, do not absorb the class 5 material.

Does teaching class 5, and therefore familiarity with the textbooks from which the tests were derived, make a difference in achievement on the test? All teachers were asked whether they had ever taught class 5, and also, whether they were currently teaching class 5. It was found that teachers who had taught class 5 scored somewhat higher on both the math as well as the science test (statistically significant at the 0.05 level), than teachers who had never taught class 5. Also, teachers who were teaching class 5 at the time of the test, scored somewhat higher on math and science than teachers who had never taught class 5. They also scored somewhat higher on these two subjects than teachers who had taught class 5 in the course of their service but who were not teaching class 5 at the time of the test. However, the differences were so small as to be insignificant in educational terms. Even the teachers who are teaching class 5 are far from mastery on class 5 math and science material they are using as teachers, and to a lesser extent Urdu material.

2.2.3 Academic qualifications and professional training

Does it hold true for inservice teachers, as it did for PTC students, that those with higher academic qualifications achieve better scores, and that those with a science stream background have better scores on math and science than their peers with equal years of academic training but an arts stream background? In addition, do different types of professional training make a difference for the achievement on the tests?

Academic background: Table 6 shows the effect of academic background of inservice teachers in the three subjects. For math and science achievement increases with increasing years of academic qualifications. The only exception is the score of 1st year FA students in math, which is more or less equal to the score of the Matric students. For Urdu there is no clear relation between academic qualification and achievement on the test. Most important is that, although there are differences, these are so small that even the teachers with university degrees do not show anything near full mastery on the math and science test.

Table 6: Average scores by academic background and subject*							
Academic background	no. of teach.	Math av.	%	Science av.	%	Urdu av.	%
Matric	273	27.5	55.0	31.6	63.2	34.0	85.0
1st year FA	26	27.4	54.8	32.0	64.0	33.3	83.2
FA/FSc complete	174	30.3	60.6	33.8	67.6	35.2	88.0
BA/BSc complete	117+	33.2	66.4	34.0	68.0	34.9	87.2
Total	590	29.5	59.0	32.7	65.4	34.5	86.2

* For this table only the largest groups by academic background are presented; the smaller ones are not shown.

\+ On the cover sheet the teachers completed, the entries for Matric and BA complete were on the same line;it is possible that some teachers with a matric ticked the BA entry, thus leading to the rather high number of BA graduates reported.

Stream: In the whole sample of 628 teachers, there were only 3 FSc graduates and 1 BSc graduate. For the inservice teachers, therefore, differences between arts and science stream for qualifications higher than matric could not be reviewed, as for the PTC students. For the matric students, about 16 percent reported a science stream background. This group scored considerably higher (9% more correct scores) on math and somewhat higher on science (3.5% more correct responses) than the group of matric students who studied in the arts stream. For Urdu there were no notable differences.

Professional training: Does professional training or the type of professional training make a difference? GCET PTC graduates scored slightly but not significantly (at the 0.05 level) higher on all three subjects, than PTC graduates with a PTC degree from Allama Iqbal Open University (distance teacher training) or the Curriculum Bureau's condensed course (a three month's course for in-service teachers leading to the PTC degree). The untrained teachers obtained the lowest average score on all subjects, but again the differences were not statistically significant. The only two groups with significantly higher scores on math (at the 0.05 level), and the highest scores on science and Urdu (though not statistically different at the 0.05 level) are the CT graduates and BEd holders. But again, in educational terms the differences are too small to be meaningful. None of the groups showed anything near full mastery on the tests.

Female arts students were also asked whether or not they studied math in their Matric. Currently general math is a compulsory subject for all Matric students in the arts stream (elective math for science students), but previously at least in some secondary institutions for girls the students could choose home economics

instead of general math. Altogether 91 out of 267 female arts students had not studied math in their matric, out of which 48 had only the matric qualification. However, having studied math did not make a difference in performance on the math test. This was true for all female teachers with an arts background, as well as for female teachers with a Matric in arts.

2.2.4 School location

Secondary schools: It is possible that secondary schools in towns are able to attract better teachers and thus offer better quality education than rural secondary schools. If this was strongly the case, one would expect teachers who followed their secondary schooling in village schools to score lower than teachers who followed their education in towns. This would apply in particular to teachers with a Matric, who would not have gone on to FA/FSc colleges which are all situated in towns.

For the 600 students who filled out this question on the cover sheet, 431 had followed their Matric in urban and 169 in village schools. However, no differences in performance were found between these groups in any of the subjects. This was also the case for the teachers with a Matric.

Primary schools: BRIDGES research found that math scores of primary class 4 and class 5 students in rural schools were lower than scores for urban students. This was particularly strong for girls. It could be that the math knowledge of teachers who are placed in rural schools is lower on average than for urban teachers, for example because teachers in towns have higher qualifications. However, no differences in performance were found between teachers assigned to urban or rural schools. This was also the case when gender was controlled.

2.2.5 Class 5 teachers

This section, to underscore the gravity of the situation, examines the content knowledge levels of the primary teachers who were actually teaching in class 5 at the time of the test. Out of the sample of 628 teachers, there were 162 class 5 teachers (95 male and 67 female) who took the tests.

Mathematics:

- The average score of the class 5 teachers was 63.0 percent correct responses (for male teachers 66.4%, female teachers 58.2%), in other words, an average of 37 percent incorrect responses;

- About one quarter of primary class 5 teachers scored less than 50 percent of the test items correct. It is unlikely that these teachers will be able to teach much of the class

5 math to their classes. If the sample is representative, this would mean that every 1 in 4 fifth class in NWFP has a teacher who has very serious deficiencies in the math content knowledge he or she is supposed to teach;

- More than half of primary class 5 teachers (about 45% of male, and over 65% of female teachers) obtained a score between 50 and 80 percent correct. These teachers also will not be able to teach much of the class 5 math content to their classes. If the sample is representative, it means that this applies to 1 out of every second class 5 in NWFP;

- Just less than one third of male class 5 primary teachers and less than 5 percent of female class 5 primary teachers obtained a score of more than 80 percent correct responses. If the sample is representative, this would mean that 1 in 3 classes 5 in boys' schools, and 1 in 20 classes 5 in girls' schools, has a teacher who probably understands most (but that does not mean all) of the class 5 math content.

Science:

- The average score obtained was 68.2 percent correct responses, or, an average of almost one third incorrect responses;

- Just less than 15 percent of class 5 primary teachers score less than 50 percent of the test items correct. This could mean that in 3 in every 20 classes 5 in NWFP the teacher probably has very serious deficiencies in class 5 science content knowledge, and cannot teach science in any meaningful way to the class 5 students;

- More than 70 percent obtained a score between 50 and 80 percent correct. If the sample is representative, this would mean that in 7 out of 10 classes 5 in NWFP, teachers probably have serious deficiencies in class 5 science content knowledge, with all its implications for the quality of teaching;

- Just less than 15 percent achieved a score higher than 80 percent correct responses. This would mean that 3 in 20 classes 5 have teachers who probably understand most (but that does not mean all) of the class 5 science content they are supposed to teach.

Urdu:

- The average score was 87.5 percent correct responses, in other words, 12.5 percent incorrect responses on average;

- 18 percent of the class 5 primary teachers obtained a score

between 50 and 80 percent correct (no scores below 50 percent were obtained). These teachers will not be able to teach much of the class 5 Urdu content to their classes. If the sample is representative, it means that this applies to 2 out of 11 classes 5 in NWFP;

- More than 40 percent of the class 5 teachers obtained a score between 80 and 90 percent. Teachers obtaining this score may have some gaps in their own Urdu class 5 level content knowledge, which will mean they cannot explain some of the Urdu material to their students. This may apply to 2 out of every 5 class 5 in NWFP;

- Just less than 40 percent teachers obtained a score higher than 90 percent. Assuming that a score of more than 90 percent (less than 3 mistakes on a 40 item test) indicates mastery, or at least near mastery, this would apply that this is applicable to 2 out of every 5 fifth class.

2.3 Item analysis

This section takes a closer look at performance on test items. Are there weaknesses and strengths in knowledge/skill areas that were represented in the tests that could provide useful clues for setting up remedial training? The Federal Curriculum Wing in Islamabad has prescribed that half of the instructional time in the GCETs should be spent on teaching content. Is the content taught appropriate for the primary school level?

It should be noted again that the PEP-II tests are curriculum based tests, with the test items directly derived from the material in the class 5 textbooks. This means that some knowledge/skill areas that would have been useful to test, such as addition and subtraction in math are not included, and that some are disproportionately represented for the purpose of this study. Also, the tests contains in some knowledge/skill areas only one or a few questions, which makes it not possible to generalize findings for these areas.

2.3.1 Item analysis Math

The math test items could be grouped into the following knowledge/skill areas: **multiplication, division, fractions, division/fraction, decimals, geometry, problem solving, measurement, other.** Every knowledge/skill area was further broken down into smaller item groups, for example, the group of test items related to fractions is broken down into mixed fractions, addition, subtraction, multiplication and division of fractions. Annex 4 gives the details for PTC students (pretest and posttest) and inservice teachers on the nine major knowledge/ skill areas, and the smaller item groups.

For **PTC students** there were gains in most, and losses in some knowledge/skill areas at the end of the training. This is also the case at the level of the smaller item subgroups. The most important finding is that, although there may be some differences in relative content knowledge of the PTC students for the different math knowledge/skill areas, scores indicate that the **entering** knowledge as well as **exiting** knowledge in all areas is insufficient. The content knowledge taught in the PTC training probably bears little or no relation to primary curriculum content, or, if it does, the instruction is not effective. This implies that all the knowledge/skill areas need to be addressed, or need to be addressed better than is the case at present, in the PTC training.

For the **inservice primary teachers**, almost all scores were very close to the posttest scores of the PTC students. This indicates that inservice teachers probably do not learn more content after leaving the GCET colleges. All the knowledge/skill areas will need to be addressed through inservice training. The breakdown used in the annex might serve as a first list of math skills that need to be taught. However, it would need extension to be more complete.

2.3.2 Item analysis Science

For science, conclusions are more difficult to draw than for math. Items can be grouped into four main knowledge/skill areas, **biology, chemistry, physics and geography/solar system** (see annex 4 for details). The level of some of the questions, particularly in physics, seems at face value rather difficult for class 5 students, but should, of course, pose less problems for GCET students with a minimum of Matric, and inservice teachers. Also, many questions require knowledge of facts, and it is of course possible that some facts may simply have been forgotten in the subsequent years of middle school, high school and further education. At the same time, in a system which relies heavily on memorization, the power to remember facts does define the more successful students, and one can expect the better PTC students and primary teachers to remember more.

For the **PTC students**, the lowest and highest averages obtained do not differ very much, indicating a fairly consistent level of knowledge accross knowledge/skill areas. A fairly large gain in scores was achieved between pretest and posttest in chemistry. It is possible that the PTC curriculum for science does address some of the chemistry also included in class 5 books, which would explain the gain in scores. Students obtained the lowest scores on physics.

The **inservice primary teachers** do somewhat less well than the PTC students on the science test. Also for the inservice teachers, physics is the weakest area, and chemistry the strongest.

However, for both PTC students and primary teachers, scores are not very high in any of the knowledge/skill areas, and also not on the smaller item groups, indicating gaps in all class 5 science content areas, and a need for remedial training.

The results on science make a strong case for curriculum based PTC training. Curriculum based training would ensure that all science content primary school children need to know is addressed in the training of the prospective primary school teachers. Training for teachers should perhaps be somewhat more sophisticated with some more explanation of underlying theory, and a emphasis on how to teach the content to primary school children of different age levels. For inservice teachers, similar inservice courses need to be designed.

2.3.3 Item analysis Urdu

For Urdu, the test was broken down into the following knowledge/skill areas: **word-attack skills, grammar, verbs, reading skills, writing skills, usage of verbs, nouns and prepositions, poetry and Islamiyat** (see annex 4 for details).

PTC students showed near mastery on most of the knowledge/skill areas. Also for Urdu there are gains as as well as losses between pretest and posttest achievement. The only areas on which an average score of less than 80% was obtained were grammar and reading skills. The score on reading skills increased, however, on the posttest to a score of over 90%.

The **inservice primary teachers** obtained a score higher than 90% on reading skills and writing skills. Their scores are fairly close to the PTC posttest scores, which again could indicate that primary teachers do not learn additional content during their service. Grammar is also the weakest area for the inservice teachers.

In Urdu, emphasis does not need to be on content knowledge or understanding of class 5 material, (perhaps with the exception of grammar), but should emphasize how to teach language to children.

3. SUMMARY

Primary teachers need to posses a thorough knowledge of the content that they need to teach to their students. It has often been suggested that many primary teachers themselves do not know all the primary curriculum content, which negatively affects quality of teaching and student learning in the primary schools.

This study aimed at assessing the knowledge PTC students studying in the GCETs and working primary teachers have of the content of class 5 math, science and Urdu material. This was done by testing some 900 PTC and CT students in six GCETs, and some 600 primary teachers in four districts with the use of PEP-II achievement tests based on the class 5 textbooks in these subjects.

Content knowledge: The test scores that were achieved indicate that almost all PTC students as well as working teachers, including the teachers that are teaching class 5, have serious problems with the class 5 math and science content. Math was the weakest subject. It is likely that they will have problems with the content of lower class levels as well. Class 5 Urdu, on the other hand, appears not to be a problem for the majority of teachers and PTC students.

PTC training: The study showed also that the PTC training did not have a major effect on students' class 5 content knowledge, needed to bring them to full mastery of primary class 5 content. It appears therefore, that the PTC training either does not address class 5 content knowledge, - although half of the instructional time in the PTC course is meant for teaching content -, or does not do this effectively.

Teaching experience: Inservice teachers do not learn any more content in the course of their work, except some in math. However, differences are so small, that not even the longest serving teachers obtained mastery. There are also no differences in achievement between trained and untrained teachers, and between trained teachers with PTC certificates from different sources (a regular GCET, AIOU, condensed course).

Academic qualification: It was found that academic qualification did have effect on the achievement on the tests. Achievement on the tests increased with increasing years of academic schooling for all subjects. Differences were largest for math. Further, PTC students and teachers with a science background scored higher on math and science than their peers with equal numbers of years of academic training but an arts background. However, even teachers or PTC students with university degrees did not achieve mastery on the math and science test.

Knowledge/skill areas: An analysis of achievement on the knowledge/skill areas represented in the test showed that

performance was not very high in any of the math and science knowledge/skill areas. For Urdu most PTC students and inservice teachers showed near mastery on most of the knowledge/skill areas in the test, with the exception of grammar.

Need for remedial training: The findings indicate a clear need for remedial training in content areas covered in the primary school curriculum, through inservice courses for working teachers, and through improved content courses in the PTC training for teacher trainees. This training should be based on existing primary textbooks and instructional materials, and focus on content knowledge, as well as methods of teaching.

GCET admission policies: The findings suggest that the present GCET admission policy of giving preference to candidates with higher qualifications before considering candidates with lower qualifications makes sense. It could also be considered to give science students preference over arts students. However, such criteria should not be rigidly applied, as obviously exceptions will continue to be needed, for example to serve rural and far-flung areas, and girls schools in rural areas in particular.

Annex 1. Test Instrument: translated PEP-II class 5 achievement tests

Math test class 5

q1. Which number is represented by IX in the Roman alphabet?
a) 11 b) 9 c) 6 d) 4
q2. Which number is exactly divisible by 6?
a) 7383 b) 3700 c) 7344 d) 4636
q3. Which are the first prime numbers?
a) 1,2,3,4,5 b) 1,2,3,5,7 c) 2,4,6,8,10 d) 2,3,5,7,11
q4. Which are the common factors of 12 and 18?
a) 1,2,12,18 b) 36 c) 1,3,4,6 d) 1,2,3,6
q5. Which is the least common multiple of 10, 20, 30?
a) 5 b) 10 c) 30 d) 60
q6. 31/100 is equivalent to which number?
a) 0.31 b) 0.031 c) 0.0031 d) 31
q7. 0.07 is equivalent to which number?
a) 7.0 b) 7/1 c) 7/10 d) 7/100
q8. What is the sum of 0.03 and 0.003?
a) 0.006 b) 0.033 c) 0.33 d) 3.3
q9. What will be the answer if we subtract 1.78 from 2?
a) 0.022 b) 2.2 c) 0.22 d) 1.76
q10. How many numbers are followed by fraction in 5.678?
a) 1 b) 2 c) 3 d) 4
q11. Which is the prime factorization of 48?
a) 48x1 b) 6x8 c) 4x3x2x2 d) 3x2x2x2x2
q12. Which are the first three multiples of 6?
a) 2,4,6 b) 12, 24, 36 c) 6, 12, 18 d) 1, 2, 3
q13. Which is the least common multiple of 2,4 and 5?
a) 8 b) 10 c) 20 d) 40
q14. 3 books cost Rs.15, what will 13 books cost?
a) Rs.195 b) Rs.65 c) Rs.45 d) Rs.39
q15. Aslam has 10, 14 and 20 marks in four subjects. What is his average mark? a) 60 b) 20 c) 15 d) 10
q16. Which is the mixed fraction? a) 18 b) 7/8 c) 9/8 d) 1 1/8
q17. 5x3/4 will be equivalent to what?
a) 3/20 b) 15/4 c) 15/20 d) 5 3/4
q18. Which is the greatest number from the numbers mentioned below? a) 1 b) 0.2 c) 0.33 d) 0.444
q19. 2x0.06 will be equivalent to?
a) 1.2 b) 0.12 c) 0.012 d) 12.0
q20. What is the answer to 0.3 x 0.3?
a) 9 b) 0.9 c) 0.09 d) 0.009
q21. What will be the answer if you divide 0.42 by 7?
a) 6 b) 0.06 c) 0.006 d) 0.6
q22. 5 x (2+4) will be equivalent to?
a) 22 b) 40 c) 30 d) 11
q23. What is the answer after solving 5/11 + 3/11 + 1/11
a) 9/11 b) 9/33 c) 15/11 d) 15/33
q24. A bus covers 90 kms in 3 hours. How much distance will it cover in 5 hours? a) 150 kms b) 54 kms c) 450 kms d) 270 kms

q25. 2/3 : 6/5 equals? a) 3/10 b) 5/9 c) 2/18 d) 4/15
q26. From the figures which one is closed? (four figures in test)
q27. What is the volume of a cube of which each side is equal to 4cms? a) 12 cms b) 16 cms c) 48 cms d) 64 cms
q28. How many right angles does this figure have? (figure in test) a) 1 b) 2 c) 3 d) 4
q29. Which is the correct name of the angle (figure in test) a) ABC b) CAB c) BCA d) BAC
q30. Which figure represents a ray of light? (four figures in test)
q31. Which of the figures is a rectangle? (four figures in test)
q32. What will be the circumference of the figure below? a) 7cms b) 12 cms c) 14 cms d) 24 cms
q33. The length of a line is 8 mtrs. What is its circumference? a) 32 sq.mtrs b) 16 sq.mtrs. c) 32 sq.mtrs. d) 64 sq.mtrs.
q34. The length of a rectangular farm is 80 mtrs, its width 50 mtrs. What is its area? a) 4000 mtrs b) 4000 sq.mtrs. c) 260 mtrs. d) 260 sq.mtrs.
q35. The length of a line of a square is 2 mtrs. What will be its area? a) 4 mtrs. b) 4 sq.mtrs. c) 8 mtrs. d) 8 sq.mtrs.
q36. What will be the area of this right angle triangle? (figure in test) a) 14 sq.cms b) 24 sq.cms.c) 28 sq.cms.d) 48 sq.cms
q37. What will be the circumference of this right angle triangle? (figure in test) a) 12 sq.cms b) 12 cms c) 6 sq.cms d) 6 cms
q38. Which is the diameter of this circle? (figure in test) a) AB b) CF c) FG d) CD
q39. On how many lines can two lines intersect with each other? on: a) one point b) two points c) many points d) none
q40. One flower represents 5 children. How many children are represented in the figure? a) 4 b) 5 c) 12 d) 20
q41. solve 7/9 - 2/9
q42. solve 5/6 - 3/4
q43. solve 7/8 x 4/15
q44. solve 4 1/6 x 3 3/5
q45. solve 2 1/4 - 4 5/6
q46. solve 6 3/5 x 4 1/6
q47. solve 2 3/14 : 8 6/7
q48. solve 100 x 50.61
q49. solve 0.5 + 0.2 - 0.3
q50. The bar below shows the performance graph of Hameed on cricket matches. In which match did he get the maximum score?

Science Test Class 5

q1. Which baby animal searches for food himself immediately after birth? a) cow b) frog c) sparrow d) cat
q2. Of which of these groups do baby animals come out of eggs? a) hen, goat, fish b) pigeon, sparrow, sheep c) sparrow, hen, pigeon d) hen, sparrow, cat
q3. Before becoming a butterfly what are the various stages of her life?

a) egg, larva, pupa b) pupa, egg, larva
c) egg, pupa, larva d) larva, egg, pupa

q4. Which plant grows by its roots?
a) wheat b) sugarcane) c) maize d) grain

q5. Which seed is more useful for airspread?
(four figures in the test)

q6. What is the use of fertilizer?
a) useful for humidity b) make soil fertile
c) finish insects d) protect crop against disease

q7. Which group contains all parts of a balanced diet?
a) flour, egg, beans, meat b) meat, sugar, potato
c) meat, flour, butter d) vegetable, mango, melon, meat

q8. Which sort of diet is most useful for curing diseases?
a) proteins b) carbohydrates c) fats d) vitamins

q9. By which of these elements can water be made?
a) Carbon, Nitrogen b) Nitrogen, Hydrogen
c) Hydrogen, Oxygen d) Oxygen, Carbon

q10. What is the name of the thing which is made by the same kind of atoms?
a) element b) composite c) mixture d) solution

q11. Matter takes how many forms? a) one b) two c) three d) four

q12. Which is the force by which water can balance its level?
a) molecular attraction b) earth's gravity
c) air pressure d) magnet's attraction

q13. Of which group are all things soluble in water?
a) lime, soda, soil b) coal, sand, sugar
c) sand, soil, lime d) salt, sugar, eating soda

q14. Clouds have how many forms? a) one b) two c) three d) four

q15. In which figure will less force be used?
(four figures in the test)

q16. Which ordinary machine can be used to cut wood quickly?
a) lever b) wrench c) spinning machine d) wheel

q17. Which energy creates green color in plants?
a) electric energy b) heat energy
c) atomic energy d) kinetic energy

q18. How are iron things affected after heating?
a) volume increases b) volume reduces
c) weight increases d) weight reduces

q19. Which of these gasses helps in putting out fire?
a) Oxygen b) Hydrogen c) Nitrogen d) Carbon Dioxide

q20. Through which things does light pass easily?
a) clean things b) semi clean things
c) unclean things d) glossy things

q21. Why do things look black?
a) they reflect all colors b) they reflect black colors
c) they dissolve all colors d) they dissolve black colors

q22. Sunlight consists of how many colors?
a) one b) three c) five d) seven

q23. Magnet attracts which thing?
a) Silver b) ferrum c) Gold d) Nickel

q24. In which of the following groups are the things magnetic?
a) Gold, Ferrum, Iron b) Zinc, Silver, Cobalt

c) Iron, Nickel, Ferrum d) Silver, Nickel, Ferrum

q25. How can electromagnetic power be stopped (interrupted?)
a) by making it hot b) by making it cold c) by disconnecting the electric power (current) d) by giving electric power

q26. On which part of the magnet will there be more iron bits?
(four figures in the test)

q27. How many types of electric charge are there?
a) one b) two c) three d) four

q28. Which balloon has a positive charge?
(four figures in the test)

q29. Which charge does an atom have?
a) positive b) negative c) both d) none

q30. How can a voice be transferred from one place to another?
a) waves in the air b) grains in the air c) d)

q31. What is the reason for an echo?
a) voice coming back after striking something b) voice coming from far c) voice coming from near d) raised voice

q32. Which planet is nearest to the sun?
a) earth b) Mercury c) Mars d) Jupiter

q33. How far is the earth from the sun? a) 10 crore kms b) 15 crore kms c) 20 crore kms d) 50 crore kms

q34. How long does the earth take in completing a round around the sun? a) one day b) one week c) one month d) one year

q35. Which part of the earth has been covered with water?
a) 1/3rd b) 2/3rd c) 3/4th d) 1/4th

Write short answers to these questions:

q36. What is the word for the spreading of seeds?
q37. Write the name of an artificial fertilizer
q38. Write the name of any simple machine
q39. Which gas helps in burning?
q40. What is the name of the smallest particle of an atom?
q41. One molecule of water contains how many hydrogen items?
q42. When vapors become cold, what does it become?
q43. A ladder is an example of which simple machine?
q44. What's the name of the bodies through which light can pass?
q45. If bodies with opposite charges come near each other, what action will take place?
q46. Write the name of any planet.
q47. How many moons does the earth have?
q48. What foods contain more vitamins?
q49. How many planets are there in the solar system?
q50. What form of matter is water?

Urdu test class 5

Part A.

q1. What is the meaning of 'struggle'(jidujuhd)?
a) carelessness b) endeavor c) rest d) useful

q2. What is the meaning of 'bravery' (shujaat)?
a) politeness b) honesty c) cowardice d) valor

q3. What is the meaning of 'ocean' (bahr)?
a) sea b) river c) land d) bay

q4. What is the meaning of 'untreatable' (laylaaj)?
a) what cannot be treated b) what can be treated
c) the one who treats d) the one who is treated

q5. What is the meaning of 'rule' (sultanat)?
a) fort b) subjects c) government d) ruler

q6. Which of the following words are feminine?
a) monkey b) elephant c) sheep d) wolf

q7. Which of the following words are plural? a) night
b) marriage procession c) person d) relations

q8. Which of the following words are adjectives?
a) carpet b) small c) leisure d) Aslam (name)

q9. A word which denotes a particular place or person is called:
a) subject b) pronoun c) common noun d) proper noun

q10. Which of the following words is a common noun:
a) Hyderabad b) school c) Hameed d) Indus (river)

q11. Which of the following sentences is in the future tense:
a) I play football b) I am playing football c) I shall play football d) I used to play football

q12. The abbreviation 'RD' stands for?
a) Peace be upon Him b) May God bless him with peace
c) God's mercy be upon him d) God has been pleased with him

q13. When we hear the name of Prophet Mohammed SAAWS we should say: a) Peace be upon Him b) May God bless him with peace
c) God's mercy be upon him d) God has been pleased with him

q14. Which of the following words is not phonetically in harmony with 'Sanwara'? a) Lalkara b) Pukara c) Barsati d) Hamara

q15. A poem in God's praise is called?
a) Tanana b) Naat c) Hamd d) Ghazal

Fill in the blanks with correct words:

q16. Do not ever expect ---- from a bad person (good)

q17. The city wakes up --- the lights (from)

q18. When praying to God, we direct ourselves towards --- (Qibla)

q19. Islam did many ---- to women. (favors)

q20. There is ---- in unity. ('Barakat')

Make sentences using the following words:

q21. wealth q22. martyr q23. knowledge q24. guidance

Rearrange the jumbled words to make correct sentences:

q25. are - of - God - all - human beings - created.

q26. this - poem - verse - of - which - is ?

q27. wood - for - burning - is - used

Give opposites:
q28. healthy q29. defeat q30. friend q31. poor q.32 distress

Part B.
Read the following paragraphs carefully and tick the correct answers to the questions:

i) Maulana Mohammed Ali Jauhar received his early education at Barreilly. He went for higher education to Aligarh. From there he went to England to get further education. There he received his BA degree. Then he returned to his homeland and started an English newspaper named 'Comrade".

q33. Where did Maulana Mohd. Ali Jauhar receive his early education? a) Karachi b) Quetta c) Aligarh d) Barreilly

q34. Where did Maulana Jauhar go for further education?
a) Pakistan b) Turkey c) England d) Afghanistan

q35. Which English paper did Maulana Jauhar start?
a) Muslim b) Comrade c) Dawn d) Sun

ii) Sultan Murad was the ruler of Turkey. He constructed a grand mosque. This mosque was very beautiful, but it had a small flaw for which the mason's hands were cut off.

q36. What was the name of the ruler of Turkey?
a) Sultan Alauddin b) Sultan Mahmood Ghaznavi
c) Sultan Murad d) Sultan Ibrahim Lodhi

q37. What did the ruler of Turkey construct?
a) a mosque b) a palace c) a fort d) a graveyard

q38. What punishment did the mason receive?
a) he was killed b) he was flogged c) he was jailed
d) his hands were cut off

iii) A man went to a forest to hunt. He saw some people in the forest cutting wood. He went further and saw some deer. He put his horse in their pursuit. The deer ran away but left behind a young deer which he caught. He put the young deer on his horse and returned. After some time he saw the mother deer was following him. He set free the young deer out of pity with the mother deer.

q39. Why did the man go to the forest? a) to cut wood
b) to have an outing c) to hunt d) to cut grass

q40. Why did the man set free the young deer? a) he was cruel
b) he was a coward c) he was brave d) he was kind

Annex 2. Average pretest scores by academic background, gender and subject

Table (a): Average pretest scores by subject and academic background, for male students (*)

Academic background	Math			Science			Urdu		
	n	av.	%	n	av.	%	n	av.	%
Matric	191	25.4	50.8	211	31.8	62.6	208	33.0	82.5
1st year FA/FSc	37	25.8	51.6	35	33.0	66.0	29	33.7	84.2
FA/FSc complete	160	29.7	59.4	136	34.2	68.4	156	34.6	86.5
BA/BSc complete	106	34.8	69.6	101	34.8	69.6	104	34.8	87.0
Total	494	28.8	57.6	483	33.2	66.4	497	33.9	84.7

(*) for this table only the largest groups by academic background are presented, the smaller ones are not shown

Table (b): Average pretest scores by subject and academic background, for female students (*)

Academic background	Math			Science			Urdu		
	n	av.	%	n	av.	%	n	av.	%
Matric	226	22.2	44.4	220	33.3	66.6	239	34.5	86.2
1st year FA/FSc	72	26.4	52.8	71	34.6	69.2	54	35.8	89.5
FA/FSc complete	80	27.5	55.0	83	35.3	70.6	87	36.0	90.0
BA/BSc complete	30	30.7	61.4	34	35.6	71.2	33	36.9	92.2
Total	408	24.6	49.2	408	34.1	68.2	413	35.2	88.0

(a) see previous table

Annex 3. Average posttest scores by academic background, gender, stream and subject

Table (a): Average posttest scores by academic background and subject

Academic background	n	Math av.	Math %	Science av.	Science %	Urdu av.	Urdu %
Matric	383	27.3	54.6	33.2	66.4	34.8	87.0
1st year FA	56	28.1	56.2	34.4	68.8	36.2	90.5
FA complete	209	30.1	60.2	34.6	69.2	36.4	91.0
FSc complete	70	35.2	70.4	36.7	73.4	36.4	91.0
BA complete	104	30.2	60.4	34.2	68.4	36.3	90.7
BSc complete	39	36.7	73.4	38.0	76.0	37.2	93.0
Total	861	29.5	59.0	34.2	68.4	35.7	89.2

Table (b): Average posttest scores by subject and academic background, for male students (*)

Academic background	n	Math av.	Math %	Science av.	Science %	Urdu av.	Urdu %
Matric	168	27.1	54.2	32.3	64.6	34.4	86.0
1st year FA/FSc	34	29.6	59.2	33.5	67.0	35.8	89.5
FA/FSc complete	158	31.0	62.0	34.7	69.4	36.1	90.2
BA/BSc complete	86	33.6	67.2	36.0	72.0	39.9	99.7 ?
Total	446	29.9	59.8	34.0	68.0	35.6	89.0

(*) see table (a)

Table (c): Average posttest scores by subject and academic background, for female students (*)

Academic background	n	Math av.	Math %	Science av.	Science %	Urdu av.	Urdu %
Matric	215	27.5	55.0	33.9	67.8	35.1	87.7
1st year FA/FSc	29	28.0	56.0	35.4	70.8	36.5	91.2
FA/FSc complete	121	31.9	63.8	35.6	71.2	36.7	91.7
BA/BSc complete	50	28.7	57.4	34.0	68.0	36.0	90.0
Total	415	29.0	58.0	34.5	69.0	35.8	89.5

(*) for this table only the largest groups by academic background are presented, the smaller ones are not shown

Table (d): Average posttest scores by subject, stream and gender for Matric students

Male	n(M)	Math av.	Math %	Science av.	Science %	Urdu av.	Urdu %
Science	118	28.9	53.8	34.0	68.0	35.1	87.8
Arts	50	22.8	45.6	28.2	65.6	32.8	82.0
Total M	168	27.1	54.2	32.3	64.6	34.4	86.0
Female	**n(F)**	**av.**	**%**	**av.**	**%**	**av.**	**%**
Science	33	31.4	62.8	34.9	69.8	34.8	87.0
Arts	177	27.0	54.0	33.9	67.8	35.3	88.2
Total F	210	27.7	55.4	34.1	68.2	35.2	88.0

Annex 4: Gains in average scores in percentages for knowledge/skill areas and item subgroups for PTC students and in-service teachers

MATH:

Average Math scores in % for knowledge/skill areas					
		Average scores (in %) PTC students			
Knowledge/ skill area	Number of test items	n=736 pret.	n=727 postt.	gain	In-service teachers, n=628
multiplication	1	31	49	18	47
division	1	69	69	0	81
fractions	11	51	54	3	66
division/fraction	3	56	54	(2)	54
decimals	11	61	57	(4)	58
geometry	14	49	55	6	53
problem solving	2	32	64	32	63
measurement	2	41	80	39	77
other	3	46	60	14	56
total	50	55	58	3	59

For **PTC students**, both the lowest as well as the highest average score have moved up between pretest and posttest, indicating improvement on posttest scores. There are gains in some, and losses in other knowledge/skill areas. The largest gains are made in problem solving, measurement and multiplication (in a narrative problem). Though categories have only few test items, it is possible that the PTC training improved these areas.

The weakest areas were multiplication (in a narrative problem), problem solving and measurement on the pretest, and multiplication (in a narrative problem), fractions, and division/ fractions on the posttest. The best scores were in decimals and division on the pretest, and division and measurement on the posttest.

For the **inservice primary teachers**, the weakest areas were multiplication (in a narrative problem), geometry, and division/ fractions. The best scores were in division and measurement. The most notable finding is that the scores for the inservice teachers are very close to the scores of the PTC students on the posttest. Only for division and fractions inservice teachers score higher than PTC students. This indicates that inservice teachers probably do not learn much more content after leaving the GCET colleges.

MATH item sub-groups	number of test items	Average scores (in %) PTC students n=736 pret.	n=727 postt.	gain	In-service teachers, n=628
multiplication	1	31	49	18	47
division	1	69	69	0	81
fractions					
o mixed fraction	1	15	72	57	83
o addition	1	67	82	15	85
o subtraction	3	47	53	6	66
o multiplication	4	62	47	(15)	60
o division	2	32	58	26	61
division/fraction					
o factors	3	62	68	6	64
o multiples	2	47	33	(14)	39
decimals					
o general	2	49	74	25	64
o decimal-fraction	2	54	72	18	67
o addition	2	48	58	10	64
o multiplication	3	70	49	(21)	56
o division	1	74	21	(52)	26
geometry					
o general	5	54	76	22	68
o angles	2	35	65	30	62
o perimeter	3	58	53	(5)	52
o area	3	46	36	(10)	35
o volume	1	31	23	(8)	22
problem solving					
o average	1	20	62	42	61
o distance	1	44	67	23	66
measurement					
o reading graph	2	40	80	40	77
other					
o Roman numerals	1	19	65	46	57
o prime numbers	1	78	38	(40)	37
o algebra	1	41	77	36	75
total	50	51	58	7	59

In the table above, knowledge/skill areas are broken down further into smaller item subgroups.

As regards the **PTC students**, also within item subgroups there is no consistent pattern in score gains, with increases in about two thirds of the item subgroups, and decreases in one third between pretest and posttest scores. The PTC training does not raise scores enough in any of the item subgroups. Also at this level, it appears that the content knowledge taught in the PTC training bears little or no relation to the primary curriculum.

The scores of the **inservice teachers** are close to the posttest scores of PTC students in most of the item sub-groups. Therefore, primary teachers do not appear to learn any more content after they start teaching in schools.

SCIENCE

Average Science scores in % for knowledge/skill areas					
Knowledge/ skill area	Number of test items	Average scores (in %) PTC students n=716 pret.	n=727 postt.	gain	In-service teachers, n=628
biology	11	73	75	2	66
chemistry	9	66	77	11	72
physics	21	64	60	(4)	59
geography/solar system	7	65	68	3	64
extra	1	72	62	(10)	52
total	50	66	67	1	65

For the **PTC students**, the lowest and highest averages obtained do not differ very much on either pretest or posttest, indicating a fairly consistent level of knowledge accross knowledge/skill areas. Some gains in scores have been made in geography/solar system and biology. A fairly large gain in scores was achieved between pretest and posttest in chemistry. It is possible that the PTC curriculum for science does address some of the chemistry also included in class 5 books, which would explain the gain in scores. Physics is the subject with the lowest scores on the pretest, and a negative gain score between pretest and posttest results. This seems to be the weakest content area within science for PTC students.

Overall, scores on biology and chemistry are fairly good, with percentage scores of over 70% on the posttest. Scores on geography/solar system follow. Physics is a weak area, and because of the large number of physics questions in the test, this brings down the average scores on the test.

The **inservice primary teachers** do somewhat less well than the PTC students on the science test. Also for the inservice teachers, physics is the weakest area, and chemistry the strongest. However, for both PTC students and primary teachers, scores are not very high in either of the knowledge/skill areas, indicating gaps in class 5 content knowledge.

SCIENCE item sub-groups	number of test items	Average scores (in %) PTC students n=716 pret.	n=727 postt.	gain	In-service teachers, n=628
biology					
1. animals					
o classification	2	66	91	25	85
o butterfly	1	51	57	6	55
2. plants					
o reproduction	3	78	67	(11)	65
o fertilizer	2	49	81	32	85
o photosynthesis	1	90	90	0	82
3. nutrition	3	64	44	(20)	45
chemistry					
o states of matter	3	68	79	11	75
o characteristics elements/compounds	5	72	73	1	67
o solution in water	1	29	91	62	88
physics					
o light	4	64	71	7	72
o electricity	3	53	55	2	55
o sound	2	87	94	7	88
o magnetism	3	59	65	6	60
o electromagnetism	1	44	66	22	44
o atoms	2	77	55	(22)	51
o interaction between forces	1	54	43	(11)	51
o friction	1	55	43	(12)	41
o effect of heat on matter	1	78	83	5	67
o machines	3	69	57	(12)	62
geography/solar system					
o geography	1	57	63	6	54
o solar system	6	72	69	(3)	66
extra					
o forms of clouds	1	71	62	(9)	52
total	50	66	67	1	65

Below smaller item subgroups for science are presented. For the **PTC students,** there is a less consistent pattern in gain scores within item sub-groups, with gains in almost two thirds of the item subgroups, and losses in just over one third between pretest and posttest scores. The scores of **inservice teachers** are again close to the posttest results of the PTC students.

Since the number of items in each item sub-group is small, it is

hard to draw definite conclusions about relative weaknesses and strengths in content knowledge for each item sub-group. However, scores were the best for both PTC students as well as inservice teachers (an average of over 80%) on animal classification, fertilizer and photosynthesis in biology (a total of 5 test items), solution in water (1 test item) in chemistry (scores on the pretest were very low on this item however), and sound (2 test items) in physics. It is clear from this table again however, that PTC training does not bring scores up enough in any of the item subgroups, and that inservice teachers do not appear to learn content in their work.

Physics is the weakest area and definitely requires attention. However, although results on biology, chemistry and geography/ solar system questions were better, they can still be considered too low considering PTC trainees and inservice teachers have at least 10 years of education and should have shown mastery on a class 5 test, and considering that they have to be prepared to teach these content areas to children.

URDU:

Average Urdu scores in % for knowledge/skill areas

Knowledge/ skill area	Number of test items	Average scores (in %) PTC students n=738 pret.	n=727 postt.	gain	Inservice teachers, n=628
word-attack skills	11	90	90	0	87
grammar	5	84	70	(14)	74
verbs	1	96	89	(5)	87
reading skills	8	77	94	15	91
writing skills	7	89	92	3	95
usage of verbs, nouns, prepositions	5	92	82	(10)	80
poetry	1	92	99	7	90
Islamiyat	2	84	94	10	84
total	40	87	88	1	87

PTC students showed near mastery on most of the item categories in the test. Also for Urdu there are positive as well as negative gains between pretest and posttest achievement. On the posttest averages above 90% were achieved in 5 of the 9 knowledge/skill areas. The only groups on which a score of less than 80% was obtained were grammar and reading skills. The score on reading skills increased, however, on the posttest to a score of over 90%. Grammar should perhaps receive more attention in PTC Urdu instruction.

Inservice primary teachers obtained a score higher than 90% on reading skills and writing skills. Their scores are fairly close to the PTC posttest scores, which again indicates that primary teachers do not learn additional content in their work. Grammar is also the weakest area for the inservice teachers.

As regards scores on item sub-groups for **PTC students**, for Urdu there are a fewer gains than losses in scores. The most notable finding is within grammar. Scores drop for all four grammar sub-groups. In fact, for the posttest performance on 3 item sub-groups is less than 70 percent, but the overall average is brought up by the fourth category where the average continues to be over 90 percent (for no other sub-item groups in the Urdu test is the score lower than 82). It is hard to imagine that the PTC training had any bearing on this drop in scores. It is clear that grammar is the poorest area in Urdu. The scores of **inservice teachers** show a roughly similar pattern, with the lowest scores on some of the grammar items, and on a test item about rhyming.

URDU		Average scores (in %)			
	number	PTC students			In-service
	of test	n=738	n=727		teachers,
item sub-groups	items	pret.	postt.	gain	n=628
1.word-attack skills					
o vocabulary	5	90	94	4	89
o rhyming	1	92	82	(10)	77
o opposites	5	89	87	(2)	90
2.grammar					
o feminine/masc.	1	84	60	(16)	51
o plural/singular	1	93	91	(2)	88
o adjectives	1	65	66	(1)	88
o nouns	2	93	66	(27)	73
3.verbs					
o future tense	1	96	89	(7)	87
4.reading skills					
o comprehension literal questions from text	8	77	95	18	91
5.writing skills					
o making sentences	4	91	93	2	95
o word order	3	88	93	5	94
6.usage verbs, nouns prepositions	5	92	82	(10)	80
7.poetry					
o types of poems	1	92	99	7	90
8.Islamiyat					
o usage of Islamic expressions	2	84	94	10	89
total	40	87	88	1	87

Annex 5. Test item numbers for item categories by subject

In this annex the item categories are presented with the numbers relating to the test items, to enable linking the analysis in para 2.4 to individual test items.

1. Math

Item category	Test item number
1. multiplication	14
2. division	2
3. fractions	
o mixed fraction	16
o addition	23
o subtraction	41,42,45
o multiplication	17,43,44,46
o division	25,47
4. division/fraction	
o factors	4,13,11
o multiples	12,5
5. decimals	
o general	18,10
o decimal-fraction	6,7
o addition	8,49
o multiplication	48,19,20
o division	21
6. geometry	
o general	31,30,38,39,26
o angles	28,29
o perimeter	32,33,37
o area	34,35,36
o volume	27
7. problem solving	
o average	15
o distance	24
8. measurement	
o reading graph	40,50
9. other	
o Roman numerals	1
o prime numbers	3
o algebra	22

2. Science

I. Biology	
1. Animals	
o classification	1,2
o life stages of butterfly	3
2. Plants	
o reproduction	4,5,36
o fertilizer	6,37
o photosynthesis	17
3. Nutrition	7,8,48
II. Chemistry	
o states of matter	11,42,50
o characteristics elements/compounds	10,9,41,19,39
o solution in water	13
III. Physics	
o light	20,21,22,44
o electricity	27,28,45
o sound	30,31
o magnetism	23,24
Physics (contnd.)	
o electromagnetism	25
o atoms	29,40
o interaction between forces	12
o friction	15
o effect of heat on matter	18
o machines	16,38,43
IV. Geography/Solar system	
o geography (water area)	35
o solar system	32,33,34, 46,47,49
V. Other	
o forms of clouds	14

3. Urdu

Item category	Test item number
1. Word-attack skills	
o vocabulary	1,2,3,4,5
o rhyming	14
o opposites	28,29,30,31,32
2. Grammar	
o feminine/masculine	6
o singular/plural	7
o adjectives	8
o nouns	9,10
3. Verbs	
o future tense	11
4. Reading skills	
o comprehension literal questions from text	36,37,38 33,34,35 39,40
5. Writing skills	
o making sentences	21,22,23,24
o word order	25,26,27
6. Usage of verbs, nouns, prepositions	16,17,18,19,20
7. Poetry	
o types of poems	15
8. Islamiyat	
o usage of Islamic expressions	12,13