Quantitative Skills Assessment in a Liberal Arts College, AUI as Example
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1. Introduction

In this work, we propose to assess AUI students in terms of quantitative skills. AUI is a Moroccan university modeled in its administrative, pedagogical and academic organization on the American university system as stressed in its mission statement. Since its inception in 1994, AUI has been following the model of a small liberal Arts college where a 1200 student body take a core curriculum of Arabic, French, English composition, Humanities, Mathematics and Science courses before getting to more specialized courses ranging from Engineering to Business to International Studies and Diplomacy.

Mathematics education is a field that has attracted a lot of money from granting agencies in the USA in the past decade. It has been realized by decision-makers in many American universities how quality mathematical education could impact on the overall performance of different programs. It is now standard to have a quantitative test requirement in many American institutions, especially Liberal Arts Colleges where students are required to show some form of quantitative literacy before they can take usual mathematics courses. This can be a formal quantitative literacy requirement or evidence of earlier records in similar remedial courses in other institutions. Following the rise of accountability throughout American liberal arts institutions in relation with accreditation, a diligent effort was given to institutional assessment as a means for evaluating student learning. The primary goal is to engage campuses in identifying the foundation of a quality liberal arts education experience and measuring students’ experience in achieving these goals – core curriculum learning and skills that anyone with a liberal arts degree should have.

A significant advancement in evaluating student learning---especially in the reaching of cognitive skills most needed nowadays such as critical thinking, analytic reasoning, problem solving, and written communications has been evidenced. At least three of the four previously cited skills clearly rely on a quality mathematical education that is difficult to reach within a liberal arts system, given the constraints and the goals aimed for by this system itself.

Since the founding of AUI, students’ achievements and abilities in terms of quantitative skills and more precisely in mathematics have never been assessed. In order to address issues such as accountability and accreditation, the university system has realized the necessity of such assessment. As a matter of fact, research related to teaching is listed as one of the goals in the AUI strategic plan for 2004-2009. Thus our study fits well within the scope of the university goals for the current period. Regardless of the outcomes of this research, it is rather comforting to notice that this study is conducted while hundreds of public and private colleges and universities are now using a variety of assessment examinations, either purchased or self-designed, to monitor student progress and improve the learning experience.

The authors would like to thank Dr. Van Lierde for her participation and help with the project as well as AUI for its support.
Along with the institutional necessity for assessing and improving teaching effectiveness, students' lack of mathematical skills can hinder the efforts to produce graduates that are able to think logically in concrete situations and find solutions to real life problems using mathematical tools taught in college. This is now of particular importance given the recent orientation of the country that emphasizes forming a target of 10,000 Engineers in Morocco by the end of 2010.

The recognition that families and students as well associated engineering studies with mathematics has scared away many students from engineering. This has been witnessed in many instances where students with low performance or just difficulties in mathematics classes prefer to switch to business studies, lured as they are by the feeling that the later studies don’t need the mathematical depth that seems to be required in engineering. This is by the way a misconception as it is now notorious that for example to pursue serious studies in Finance one needs deep understanding of probability theory and stochastic processes. Whereas in the US mathematics departments or Mathematics Learning Centers offer several remedial courses ranging from Basic College Algebra to Pre-calculus to offer a chance for everyone to appreciate the mathematic subject matter, AUI only offers MTH1399, which is a shortened version of Pre-Calculus, as typically students from the School of Humanities or the Business School are the ones that take such a course.

It has been recognized by the university system that high school graduates are not always ready nor are they prepared to take college level courses. Since Fall 2000 the Center for Academic Development (CAD) has been in charge of helping students to improve their study and learning skills without being able so far to address student weaknesses in Mathematics as there is no CAD course that addresses quantitative skills. Until now, there has been no serious study of the effectiveness of CAD in addressing quantitative skills of AUI students. Our study could also be seen as a first step toward that direction. More precisely, the following questions were investigated:

1. Are students well prepared to take mathematics courses?
2. Are students able to apply the acquired mathematical knowledge in concrete situations related to their field of study?
3. Do students need mathematical concepts that are not addressed by the current curriculum?

To investigate these questions, we formulated the following hypotheses:

a. Humanities students are well prepared to take mathematics courses
b. Humanities students take full advantage of their mathematics curriculum and can apply it to concrete situations.
c. Humanities students can use data, analyze it and diagnose it.
d. Business students are well prepared to take mathematics courses
e. Business students take full advantage of their mathematics curriculum and can apply it to concrete situations.
f. Business students need mathematical concepts not addressed in current curriculum.
g. Engineering students are well prepared to take mathematics courses
h. Engineering students can use acquired mathematical knowledge in concrete situations.
i. Engineering students need in their curriculum or their research mathematical concepts and tools not addressed by current mathematics curriculum.

These constituted our null hypothesis. We then sampled our population and aimed to measure the performance of our students against these hypotheses. Assessment of students' learning in general can be done in different ways (tests in class, contracted testing by outside companies, questionnaires, etc.). We have opted to test specific groups of students by choosing a sample in each group to assess whether they have acquired a certain minimum level. As there is no formalized institutional testing facility, all the testing items were produced by our team. We clearly depended on the student’s willingness to cooperate. As an incentive to participating in the study, the university provided for a compensation that was announced to be commensurate with the number of correct answers obtained. This was done in order to have students participate and actually try their best to answer the questions correctly. The tests were divided in two parts of about fifty minutes each to maximize the students output, rather than giving the tests all at once.

As pioneering as it can be, with relative imprecision due to all facts cited above, the study results would be beneficial to the institution, administration, faculty and students.

On the one hand and in contrast with professionals assessments, done by agencies and contracted for, our study was done by AUI faculty involved in this project, thus this study is tailored to the specific problems and situation at AUI. This has several advantages: it involves faculty in having a potential impact on the curriculum of the university in terms of quantitative skills; it relates to courses that are taught at AUI; it is cost attractive; the process of making the tests seemed to stimulate informal discussions among faculty. As a result, not only the usefulness of the assessment outcomes is at stake, but also the assessment process itself will certainly have an added value on the quality assurance aimed for by the university system.

Our approach could easily be partly generalized to other disciplines ranging from Computer Sciences to Management to English Composition. Taking a sample of students and testing what they retained after taking a certain number of courses is easily transferable to different subjects. This could be a complement to our Exit Test, the MFT (major field test) as it would also provide yet another indicator of our students achievements. In that sense, we believe this study can be seen as a starting point and pioneering in the sense of triggering further research work in other disciplines.

2. Methodology

For the hypothesis regarding the well preparedness of students of different schools (a,d,g) mentioned in the introduction, we prepared tests to measure entry-level, but also in-class progress, in-class learning and impact of educational efforts in a given semester. At the beginning and end of the Fall 2006 semester, we administered a 'first week' test to students in the following classes: MTH1300 (discrete mathematics for business and humanity students), and MTH1303 (differential and integral calculus). These are the typical first mathematics courses taken by
students belonging to the different programs at AUI. To ensure measurability of efforts and in class progress, we administered the same test twice. Each of the tests consisted of 20 true/false items. As the tests were administered in-class, in the presence of the instructor, we can safely assume that the responses are representative for a typical class. The number of participants per class is given in the following table.

Table 2.1: Student’s participation in the test

<table>
<thead>
<tr>
<th>Course</th>
<th>First week test</th>
<th>Last week test</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTH1303 (Calculus 1)</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>MTH1300 (Business Calculus 1)</td>
<td>91</td>
<td>103</td>
</tr>
</tbody>
</table>

3. Data Analysis

3.1. Quantitative Skills Assessment for Freshman Students:

First Week Test:

Table 3.1

<table>
<thead>
<tr>
<th>Student</th>
<th>Question</th>
<th>Min correct answers</th>
<th>Max correct answers</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1303</td>
<td>33</td>
<td>4</td>
<td>19</td>
<td>13.33</td>
<td>3.05</td>
</tr>
<tr>
<td>Math 1300</td>
<td>91</td>
<td>1</td>
<td>14</td>
<td>8.58</td>
<td>2.81</td>
</tr>
</tbody>
</table>

Last Week Test:

Table 3.2

<table>
<thead>
<tr>
<th>Student</th>
<th>Question</th>
<th>Min correct answers</th>
<th>Max correct answers</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1303</td>
<td>24</td>
<td>8</td>
<td>20</td>
<td>13.96</td>
<td>3.04</td>
</tr>
<tr>
<td>Math 1300</td>
<td>103</td>
<td>5</td>
<td>19</td>
<td>10.83</td>
<td>2.55</td>
</tr>
</tbody>
</table>

From the above two tables in Math 1303 there was an improvement of number of correct answers from four to eight. The mean slightly improved from 13.33 to 13.96 which is expected as the course does not really address the questions in the questionnaires (high school/misconceptions) the standard deviation remained the about the same. We can conclude that the course increases the maturity of student regarding mathematical needed without having an actual impact on the standard deviation. The acquired mathematical maturity of student increased uniformly.

In Math 1300 (discrete mathematics course mandatory for humanities and business students) we note a light increase from one to five minimum correct answers out of 20 easy questions. While we observe an increase in the mean from 8.58 to 10.83 as well as a reduction in the standard deviation from 2.81 to 2.55, it is still remarkable that the mean is 10.83 while we expect a passing mean of 14. This clearly shows a necessity for the design for a more appropriate remedial course for this population.
3.2. Quantitative Skills Assessment for non Freshman Students

In order to collect data to test the other hypotheses, we devised three tests, one for each school. We also devised two questionnaires, one for the SSE students and another for the SBA and SHSS students. These would give us information about the students' working habits as well as their perception of possible origins of difficulties encountered in quantitative reasoning. The population consisted of (i) 22 SHSS students that have completed MTH1399 + MTH1300 + SSC2401 or MTH1300 + MTH1301 + SSC2401 (ii) 201 SBA students that have completed MTH1300 + MTH1301 and (iii) 65 SSE students that have completed the three mathematics courses (MTH1303, MTH2301, and MTH3301). All of these students were contacted by email. Despite the advertising and the incentives, there were 10 students from the humanities, 8 students from the SBA and 13 students from SSE, a total of 31 students who participated to our study. As our tests were at the end of the semester, many students were preparing for their final. This might explain the low response to our numerous invitations sent to the students.

3.2.a. General performance:
The tests were divided in two parts with 10 questions per test, each test lasted 50 minutes. The students could not leave the examination room before the end of the duration of each test. Raw descriptive statistics about these tests were generated using SPSS and they are including herein for the reader perusal.
SSE test 1: Minimum correct answers were 0 and Maximum number of correct answers 7. The Mean was 2.46 and standard deviation was 1.71.
SSE test 2: Minimum correct answers were 2 and Maximum number of correct answers 7. The Mean was 4.54 and standard deviation was 1.51.
SBA test 1: Minimum correct answers were 1 and Maximum number of correct answers was 5. The Mean was 2.63 and standard deviation was 1.60.
SBA test 2: Minimum correct answers were 2 and Maximum number of correct answers was 6. The Mean was 4.50 and standard deviation was 1.41.
SHSS test 1: Minimum correct answers were 2 and Maximum number of correct answers was 6. The Mean was 4.30 and standard deviation was 1.34.
SHSS test 2: Minimum correct answers were 2 and Maximum number of correct answers was 5. The Mean was 3.40 and standard deviation was 1.17.

A quick glance at these results reveals a poor performance throughout the schools with a mean never exceeding 4.54. The Standard Deviation is higher in the SSE and SBA than it is in SHSS. Notice that we can normally expect an average of 7 with a standard deviation equal to 1.

3.2.b. Hypothesis Testing Results

Given the large spectrum of students that enroll at AUI and the variety of their quantitative backgrounds (Moroccan system, private system, French system, American system), we subdivided our hypothesis testing into three main subgroups. We then decided that the null hypothesis was 60%. Our choice was motivated by the admission process at AUI where students are expected to have an average of 60% in their high school and are admitted on their potential. It
is a common belief that when these students will be given the right environment (advising, low professor/students ratio, good professors, modern facilities campus, restaurant, library, labs, sport complex ) their performance would increase by 10 making a D student a C one, etc.. We also thought that if a student has taken a course, he/she should at least have mastered 60% of the material taught.

- Humanities students are well prepared to take mathematics courses

The questions used to test this hypothesis are in the Appendix 2

The analysis of the score of the sample population gave the following:

<table>
<thead>
<tr>
<th>Correct questions</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>50,0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>10,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Since there were 4 questions in this item with a mean of 1.7 and a standard deviation of 0.67, and assuming normal distribution, the percentage of Humanities students that are not well prepared to take mathematics courses at AUI is given by the z-score

\[ P(X < .60) = P(Z < \frac{2.4 - 1.7}{0.67}) = P(Z < 1.0447) = 1/2 + .3508 = .8508 \]

that is only 15% Humanities students are really prepared to take mathematics courses at AUI

**Humanities students take full advantage of their mathematics curriculum and can apply it to concrete situations.**

Questions used to test this hypothesis

The analysis of the score of the sample population gave the following:

<table>
<thead>
<tr>
<th>Correct questions</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Since there were 8 questions in this item with a mean of 2 and a standard deviation of 0.82, and assuming normal distribution, the percentage of Humanities students that fail to take full advantage of their mathematics curriculum or cannot apply it to concrete situations is given by

\[ P(X < .60) = P(Z < \frac{4.8 - 2}{0.82}) = P(Z < 3.414) = 1/2 + .4948 = .9948 \]

the z-score
that is 99% of Humanities students don’t take full advantage of their mathematics curriculum and would be able to apply it to concrete situations.

**Humanities students can use data, analyze it and diagnose it.**
Questions used to test this hypothesis can be found in the Appendix.
The analysis of the score of the sample population gave the following:

**Table 3.5**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10,0</td>
</tr>
<tr>
<td>1</td>
<td>50,0</td>
</tr>
<tr>
<td>2</td>
<td>30,0</td>
</tr>
<tr>
<td>3</td>
<td>10,0</td>
</tr>
<tr>
<td>Total</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Since there were 3 questions addressing this item with a mean of 1.4 and a standard deviation of 0.84, and assuming normal distribution, the percentage of Humanities students that cannot use data, cannot analyze it or cannot diagnose it is given by the z-score

\[
P(X < .60) = P(Z < \frac{1.8-1.4}{.84}) = P(Z < 0.4761) = 1/2 + .1808 = .68
\]

that is about 68% of Humanities students cannot use data, or cannot analyze it or cannot diagnose it.

For the business school the findings are not reliable because the number of students in the sample is too small.

**Business students are well prepared to take mathematics courses**
Questions related to this hypothesis can be found in the Appendix:
The analysis of the score of the sample population gave the following:

**Table 3.6**

<table>
<thead>
<tr>
<th>Correct answers</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>25,0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>25,0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>12,5</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Since there were 6 questions in this item with a mean of 3.38 and a standard deviation of 1.69 assuming normal distribution, the percentage of Business students that cannot use data, cannot analyze it or cannot diagnose it is given by the z-score

\[
P(X < .60) = P(Z < \frac{3.6-3.38}{1.69}) = P(Z < 0.1301) = 1/2 + .0517 = .5517
\]

that is about 55% of Business students are not prepared to take mathematics courses at AUI.
Business students take full advantage of their mathematics curriculum and can apply it to concrete situations. Questions related to this hypothesis can be found in the Appendix. The analysis of the score of the sample population gave the following:

Table 3.7

<table>
<thead>
<tr>
<th>Correct answers</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Since there were 12 questions in this item with a mean of 3.75 and a standard deviation of 1.67 and assuming normal distribution, the percentage of Business students that cannot take full advantage of their mathematics curriculum or cannot apply it to concrete situations is about 98% of Business students don’t take full advantage of their mathematics curriculum or cannot apply it to concrete situations.

Engineering students are well prepared to take mathematics courses. Questions related to this hypothesis are in the Appendix. The analysis of the score of the sample population gave the following:

Table 3.8

<table>
<thead>
<tr>
<th>Correct answers</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Since there were 5 questions in this item with a mean of 2.85 and a standard deviation of .99 and assuming normal distribution, the percentage of SSE students that are not well prepared to take mathematics courses at AUI is given by the z-score

\[ P(X < .60) = P\left(Z < \frac{3 - 2.85}{.99}\right) = P(Z < 0.1515) = 1/2 + .0596 = .5596 \]
that is **56% SSE students are not really prepared to take mathematics courses at AUI**

**Engineering students can use acquired mathematical knowledge in concrete situations.**
We refer the reader to the Appendix for questions related to this hypothesis.

The analysis of the score of the sample population gave the following:

<table>
<thead>
<tr>
<th>Table 3.9</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>15,4</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>53,8</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>15,4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>15,4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Since there were 4 questions in this item with a mean of 1.31 and a standard deviation of .95 and assuming normal distribution we could infer that the percentage of SSE students that cannot use acquired knowledge and apply it in concrete situations is given by the z-score

\[
P(X < .60) = P(Z < \frac{2.4 - 1.31}{.95}) = P(Z < 1.1473) = 1/2 + .3729 = .87
\]

this implies that only **13% can use acquired mathematical knowledge and apply it to concrete situations.**

**Engineering students need in their curriculum or their research mathematical concepts and tools not addressed by current mathematics curriculum.**
The analysis of the score of the sample population gave the following:

<table>
<thead>
<tr>
<th>Table 3.10</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00</td>
<td>11</td>
<td>84,6</td>
</tr>
<tr>
<td>1,00</td>
<td>2</td>
<td>15,4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
</tr>
</tbody>
</table>

There was only one question related to this hypothesis, namely one on linear algebra about eigen values and eigenvectors. Since there was only one question in this item with a mean of .1538 and a standard deviation of .3755 and assuming normal distribution we could infer that the percentage of SSE students that cannot answer a simple question in linear algebra for example is given by the z-score

\[
P(X < .60) = P(Z < \frac{0.60 - 0.1538}{.3755}) = P(Z < 1.1882) = 1/2 - .3810 = .88
\]

i.e.

which can be interpreted as **about 88% of engineering students would need a course in linear algebra.**
3.3. Questionnaire analysis

Despite the fact that the questionnaire reveals some good working habits among students, the statistical analysis of the test was not as expected. In the questionnaire 50% of Humanities students claimed to spend more than six hours per week to prepare for their math classes, 90% do not suffer from mathematics phobia, and 70% ask for help. Furthermore all the students claimed to take notes, 60% of them participate in class discussion and that English does not impede their understanding of mathematics courses. The weakness of the students can be seen in the use of a calculator since 90% of them would use a calculator for a simple algebraic expression and 80% of the students who replied to the questionnaire needs a preparatory mathematics class moreover 70% of the students desired mathematics classes that covers different subjects than the one that are currently offered. The weak results can be explained by both the weak preparation before going to classes and discrepancies between methods learned in high school and what is expected in college.

In the engineering school the difficulties expressed by students are due to the lack of preparation before going to classes (84.6% of the students) and 15.2% suffered from discrepancies between methods learned in high school and what is expected in college. 38.5 % of the SSE students think that there should be a preparatory class in mathematics offered by AUI. Moreover 46.2% think that the university should offer mathematics classes that cover different subjects than the current offered. Furthermore 38.5% of the students who replied to our questionnaire think that there are gaps between high school mathematics and the university required level.

In the business school the mathematics phobia concerns only 12.5%. 62.5% of the students experience difficulties because of the lack of preparation before coming to classes. 25% of the students highlighted the discrepancies between methods learned in high school and what is expected in college. The SBA students are equally divided when asked about preparatory classes in mathematics for freshman students. 50% of the students requested new mathematics classes that cover different subjects than the currently offered.

4. Recommendations and Conclusions

The analysis outlined before allowed us to spell out some conclusions. We will also try to find some possible reasons for the results observed, and hence formulate some recommendations.

From the analysis of the data, it follows that students are not well prepared to take math courses. While we see that there is improvement in the averages and reduction of the standard deviation, which is what the AUI system is all about (admission on potential, increase the performance and reduce the discrepancies among students according to a normal curve) we clearly see for example that the mean attained in MTH1300 for example is still low. As these first math classes require some mathematical skills, one cannot assume that at the end of the semester, the student will have
the background required to take that class. The purpose of the class is not to provide the student with the background necessary to start the class. In that sense, it is not that surprising that we do not see a huge improvement in the results between the beginning and the end of the semester.

It is also clear that the retention of knowledge over several semesters is very poor. As an example for our assertion, it suffices for example to see that for the engineering students in Test 1 question 7 was about computing a simple derivative involving trigonometric functions with the function secant (studied in Calculus 1), question 9 and question 10 were about convergence of series (studied in Calculus 2); it is interesting that only 2 students among the 13 selected were able to give a right answer to these three questions, that is 84% missed these three questions. One plausible reason is that these notions are not used extensively in later courses, thus they get “lost”.

There are several possible reasons for the weak background of the students and for the poor improvement they make inside one class and the poor improvement they make later on.

From the results of our questionnaires, we can conclude that math phobia is not a reason for low performance, at least according to the students. However, there seems to be a gap between high school and university.

As follows from the results on the first week tests, the students don’t have the right background to start their mathematics classes. This is a general phenomenon now and it has been assessed in several American universities. However if many students are already behind when they start in the US, 40 percent of four-year college students and 63 percent of two-year students do take at least one remedial course.[M.M]

It would be good to look more closely at the gap between high school and university and to investigate in further details the reason for this gap. This is a problem that deserves further study.

Clearly the students who come to AUI are not at the mathematical level we expect them to be. Increasing the required mathematical minimum level of students will not necessarily be the only solution to this problem. In addition to this requirement at the entry level in terms of high school performance and results in the numerical and spatial parts of our general admission test, there ought to be accompanying measures that consolidate this commitment. We do believe indeed it would be possible to make our students more successful in learning mathematics, if we as a university are able to emphasis more the importance of the subject by including one or several courses at the CAD level. These courses don’t only need to teach only how to think mathematically but also to help students overcome their deficit in terms of ability to apply concepts to concrete situations correctly. As we pointed out earlier, there is no specific CAD course that focuses on this aspect so far. Similar to what is done in some universities in the US, AUI could offer several remedial courses by CAD. This would have numerous benefits. As it would teach the thinking skills our students lack to be successful in learning mathematics, it would prepare them for the mathematics courses they need in their different majors. Especially in SSE, many first year students complain about the fact that they have to wait one year before they can start taking courses in their major. A mathematical thinking course would help to keep those students motivated and interested. At the same time, it could also give them a better idea about whether they are really interested in science. On the other hand, students in SBA and SHSS often
express their frustration with the fact that they spend up to one year in the Language Center and in CAD before they start taking math, which means that they lost all feeling for and interest in mathematics before they even start taking any mathematics class at university. For those students a mathematics class at the level of CAD could also be of interest.

From the feedback we received from SSE colleagues, we conclude that there is a need for more mathematics classes in terms of content. As an example it would be sensible to reinstate a course in linear algebra for all degrees in engineering offered by the SSE. Linear algebra is used throughout engineering majors and is standard in colleges of engineering. Another issue worth thinking about is a potential calculus sequence reform (three calculi courses instead of two) in conjunction with the discussion sessions. In addition to the discrepancies in the math prerequisites in the different programs, it might be useful to investigate whether some classes in mathematics could be offered. These could be: logic for computer science, algebra and number theory, and a second course in probability.

For SBA and SHSS students there are only three mathematics classes offered. However, students in the different programs in these schools have a wide variety of backgrounds and different needs. Students need mathematics in many classes (social statistics, accounting, economics, business statistics and so on). After a placement test, students could take the course that will be most beneficial for them. According to us, it would be worth considering more choice in mathematics courses for students in SBA and SHSS that could reflect their different need. It might be more beneficial for the students to reach the minimum required level by taking classes at their level.

Our students seem to have a problem in transferring mathematical knowledge from one class to another. Possible reasons for this problem are the small number of mathematics courses offered, or the time between two different mathematics courses. In that regard, it would be interesting to see if this is a general phenomenon in Liberal Arts Colleges or is it just the case of AUI. To answer this question, one needs to conduct the same kind of assessment, with the same conditions in a different liberal arts college. Also of interest would be a comparative study about retention of knowledge and its transfer from one class to another in a University or College that offers a degree in Mathematics and a Liberal Arts College where there is no degree offered in Mathematics.

As a conclusion, it is our belief that if we do not forthrightly address the problems outlined above, the level of our students will fall farther behind and we risk losing the preeminent position AUI has in Morocco that inspires pride and imitation.

Finally, we would like to thank all professors that helped one way or another, either by answering positively requests to give their feedback at one point or another, or by allowing questionnaires in their class time. We are also indebted to the AUI management system for helping out with the usual support.
References


Appendix 1 Tests

Quantitative Skills Assessment at a Liberal Arts College, AUI as an Example
Engineering Students Test

Please circle only one answer.
Please make every effort to answer the question after logical thinking and use of acquired knowledge in the quantitative courses you took. Your contribution is very important to the future of quantitative skills at AUI.
Thank you.

1. Extensive experience with fans of a certain type used in diesel engines has suggested that the exponential distribution provides a good model for time until failure. Suppose the mean time until failure is 25,000 hours. What is the probability that a randomly selected fan will last at least 20,000 hours?

   a) \( \frac{20,000}{25,000} \)
   b) \( 1 - \frac{20,000}{25,000} \)
   c) \( e^{- \frac{20,000}{25,000}} \)
   d) \( 1 - e^{- \frac{20,000}{25,000}} \)
   e) None of these

2. The number of requests for assistance received by the helpdesk of AUI computer system is a Poisson process with rate \( \alpha = 4 \) per hour. Compute the probability that exactly 10 requests are received during a particular 2-hour period.

   a) \( \left( \frac{4}{10} \right)^{10} \)
   b) \( \frac{4}{10} \left( e^{- \frac{4}{10}} \right) \)
   c) \( \frac{8^{10}}{10!} e^{-8} \)
   d) \( 2 \left( \frac{4^{10}}{10!} e^{-4} \right) \)
   e) None of these

3. Suppose the force acting on a column that helps to support a building is normally distributed with mean 15.0 kips and standard deviation 2 kips. What is the probability that the force is between 13 and 17 kips?

   a) 0.4452
   b) 0.9452
   c) 0.68
   d) 0.84
   e) None of these

4. If we select 4 numbers from 16, what is the probability that these numbers correspond exactly to the first, second, third and fourth horse in a 16 horse's race?

   a) \( _{16} P_4 \)
   b) \( _{16} C_4 \)
   c) \( \frac{1}{_{16} P_4} \)
   d) \( \frac{1}{_{16} C_4} \)
   e) None of these

5. For the sets of data \( A = \{1,2,3,4,5,6\} \) and \( B = \{2,4,6,8,10,12\} \) the correlation coefficient would be
a) -1   b) 1   c) 2   d) 6   e) None of the above

6. Find the volume generated by rotating the area bounded by \( y = \sqrt{x} \), \( y = 0 \), \( x = 4 \) about the \( x \)-axis.

a) \( 8\pi \)   b) \( 4\pi \)   c) \( 6\pi \)   d) \( \frac{7\pi}{2} \)   e) None of the above

7. If \( f(x) = (\tan 2x - \sec 2x)^3 \), then \( f'(\frac{\pi}{8}) \) equals:

a) \( (1 - \sqrt{2})^3 \)   b) \( \sqrt{2}(1 - \sqrt{2})^3 \)   c) \( -6\sqrt{2}(1 - \sqrt{2})^3 \)   d) \( -6\sqrt{2} \)   e) None of the above

8. If \( f(x, y) = x^2 + y^2 \), then \( f_{xy} = \frac{\partial^2 f}{\partial x \partial y} \) equals:

a) \( 2x + 2y \)   b) \( 2x \)   c) \( 2y \)   d) 0   e) None of these

9. The series \( \sum_{n=1}^{\infty} \frac{1}{4^n} \)

a) converges to 0   b) converges to 1   c) converges to \( \frac{1}{3} \)

d) diverges   e) converges, but not to any of these

10. The series \( \sum_{n=1}^{\infty} \frac{n}{4n - 1} \)

a) converges to 0   b) converges to 1   c) converges to \( \frac{1}{4} \)

d) diverges   e) converges, but not to any of these
11. Evaluate the given integral by interpreting it as an area: \( \int_0^3 (9 - x^2)^{1/2} \, dx \)

a) 6\( \pi \)  

b) 9\( \pi \)  

c) \( \frac{9\pi}{4} \)  

d) 12\( \pi \)  

e) None of these

12. The life of an electronic system is \( Y = X_1 + X_2 + X_3 + X_4 \), the sum of the subsystem component lives. The subsystems are independent, each having exponential failure densities with mean time between failures of 4 hours. In order to compute the probability that the system will operate at least 24 hours, you would you use

a) the binomial distribution  

b) the hyper-geometric distribution  

c) the exponential distribution  

d) the gamma distribution  

e) None of these

13. What is the GCD (greatest common divisor) of 18 and 60?

a) 6  

b) 9  

c) 18  

d) 1080  

e) none of the above

14. What is the LCM (least common multiple) of 18 and 60?

a) 180  

b) 6  

c) 1080  

d) 18  

e) none of the above

15. What is the negation of “if \( p \), then \( q \)”? 

a) \( p \) and not \( q \)  

b) if not \( p \), then not \( q \)  

c) not \( p \) and not \( q \)  

d) (not \( p \)) and \( q \)  

e) none of the above

16. The inverse of \( \begin{bmatrix} 1 & -2 \\ 2 & -6 \end{bmatrix} \) is 

a) \( \begin{bmatrix} -1 & -1/2 \\ -1 & -1/2 \end{bmatrix} \)  

b) \( \begin{bmatrix} -1 & -1 \\ -1 & -1/2 \end{bmatrix} \)  

c) \( \begin{bmatrix} -1 & -1/2 \\ -1 & 0 \end{bmatrix} \)  

d) \( \begin{bmatrix} -1 & 0 \\ -1 & -1/2 \end{bmatrix} \)  

e) None of these

17. Let \( A = \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 \\ 0 & 0 & 4 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \) and let \( f: \mathbb{R}^4 \rightarrow \mathbb{R}^4 \) be defined by \( f(X) = AX \). Find distinct vectors \( u_1, u_2, u_3, u_4 \in \mathbb{R}^4 \) and scalars \( \lambda_1, \lambda_2, \lambda_3, \lambda_4 \in \mathbb{R} \) such that \( f(u_i) = \lambda_i u_i \) for \( i = 1, 2, 3, 4 \).
a) \( u_1 = (1,0,0,0), u_2 = (0,1,0,0), u_3 = (0,0,1,0), u_4 = (0,0,0,1), \lambda_1 = 2, \lambda_2 = 3, \lambda_3 = 3, \lambda_4 = 1 \)

b) \( u_1 = (1,0,0,0), u_2 = (0,1,0,0), u_3 = (0,0,1,0), u_4 = (0,0,0,1), \lambda_1 = 1, \lambda_2 = 1, \lambda_3 = 1, \lambda_4 = 1 \)

c) \( u_1 = (2,0,0,0), u_2 = (0,3,0,0), u_3 = (0,0,4,0), u_4 = (0,0,0,1), \lambda_1 = 1, \lambda_2 = 1, \lambda_3 = 1, \lambda_4 = 1 \)

d) \( u_1 = (2,0,0,0), u_2 = (0,3,0,0), u_3 = (0,0,4,0), u_4 = (0,0,0,1), \lambda_1 = 2, \lambda_2 = 3, \lambda_3 = 3, \lambda_4 = 1 \)

e) None of the above

18. If we want to perform a preorder search of a binary tree, then we can say informally that

a) We visit the root first. Then we search the left subtree (if it exists) and then the right subtree (if it exists).

b) We first search the left subtree (if it exists), then we visit the root of the tree, and then we search the right subtree (if it exists).

c) We first search the left subtree (if it exists) and the right subtree (if it exists) and then we visit the root of the tree.

d) We search the tree level by level, from the left to the right.

e) None of the above.

19. For a given graph, an Euler path

a) is a path that includes every edge exactly once.

b) is a path that goes through all vertices.

c) is a path that goes through all vertices only once.

b) is a path that skips at most one vertex.
e) None of the above
20. Which matrix represents the following relation on the set \{a, b, c, d\}: 
\{(a, b), (b, c), (b, d), (c, c), (c, d)\}?

\[
\begin{align*}
\text{a) } & \begin{pmatrix}
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 1 \\
0 & 0 & 1 & 1 \\
0 & 0 & 0 & 0 \\
\end{pmatrix} & \quad \text{b) } \begin{pmatrix}
0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 \\
0 & 1 & 1 & 0 \\
0 & 1 & 1 & 0 \\
\end{pmatrix} & \quad \text{c) } \begin{pmatrix}
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 1 \\
0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 \\
\end{pmatrix} \\
\text{d) } & \begin{pmatrix}
0 & 0 & 1 & 1 \\
0 & 0 & 1 & 1 \\
0 & 0 & 1 & 1 \\
0 & 0 & 0 & 0 \\
\end{pmatrix} & \quad \text{e) None of the above}
\end{align*}
\]
Quantitative Skills Assessment at a Liberal Arts College, AUI as an Example
Humanities Students Test

Please circle only one answer.
Please make every effort to answer the question after logical thinking and use of acquired knowledge in the quantitative courses you took.
Your contribution is very important to the future of quantitative skills at AUI.
Thank you.

1. The standard deviation for a given data set can exceed its range
   a. sometimes  b. never  c. 50% of the times  d. rarely  e. almost all the time

2. In a normal probability distribution, the area between the mean and a given Z score can exceed 0.6
   a. sometimes  b. never  c. 50% of the times  d. rarely  e. almost all the time

3. For a symmetrical normal curve the mean, mode, and median all coincide
   a. always  b. never  c. 50% of the times  d. rarely  e. almost all the time

4. For a skewed distribution to the left, the order of the three common central tendency measures, from the left to the right is
   a. median, mean and mode.  b. mean, median and mode  c. mode, mean and median  
d. median, mode and mean  e. none of these

5. For the following data sets $A = \{1,3,4,2,7,6,8\}$ and $B = \{1,3,4,2,7,25,19,8\}$ the medians of the two different sets are
   a. the same  b. different  c. almost the same  d. don’t exist  e. none of these

6. The bureau of the census reports that the mean family income in United States is $40,000 with a standard deviation of $5000. We can safely infer that the percentage of families in the US that have an income less than $50,000 is about
   a) 68%  b) 84%  c) 99%  d) 34%  e) none of these

7. If $\log_4(3x + 1) = \log_4(3x - 2) + 1$, then $x$ equals
   a) −4  b) $\sqrt{5}$ and $-\sqrt{5}$  c) 1  d) 3  e) None of the above
8. The monthly income of a group of 20,000 professional people is normally distributed with mean \( \mu = 8000 \text{MAD} \) and standard deviation \( \sigma = 2000 \text{MAD} \). What is the percentage of professionals from this group that has an income of less than 10,000 MAD?

a) 68%  
   b) 84%  
   c) 99%  
   d) 100%  
   e) none of these

9. A landscaper earns 200 MAD per day when working and loses 40 MAD per day when not working. If the probability of working on any day is \( \frac{4}{7} \), find the landscaper’s expected daily earnings.

a) \( \frac{800}{7} \)  
   b) \( \frac{120}{7} \)  
   c) \( \frac{680}{7} \)  
   d) \( \frac{160}{7} \)  
   e) none of these

10. The winner of a contest may choose any two of six different prizes. How many choices are possible?

a) 15  
   b) 20  
   c) 25  
   d) 30  
   e) 36
11. The table below gives the probability that $X$ units of a company’s product is demanded weekly. Determine the expected weekly demand:

<table>
<thead>
<tr>
<th>$x$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P(X = x)$</td>
<td>0.05</td>
<td>0.20</td>
<td>0.40</td>
<td>0.24</td>
<td>0.10</td>
<td>0.01</td>
</tr>
</tbody>
</table>

(a) 1      (b) 2      (c) 2.71    (d) 2.17    (e) none of these

12. Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?

(a) $16,000  (b) $20,000  (c) $15,000  (d) $25,000  (e) None of these

13. At a restaurant a complete dinner consists of an appetizer, an entree, a dessert, and a beverage. The choices for the appetizer are soup or juice; for the entree the choices are chicken, fish, steak, or lamb; for the dessert the choices are cherrie jubilee, fresh peach cobbler, chocolate truffle cake, or blueberry rolypoly; for the beverage, the choices are coffee, tea, or milk. How many complete dinners are possible?

(a) 94  (b) 96  (c) 98  (d) 100  (e) None of these

14. If $x$ satisfies the inequality $|x - 2| \leq 4$ then

(a) $x \leq 6$      (b) $x \geq -2$      (c) $-2 \leq x \leq 6$      (d) $x \geq 6$      (e) None of these

15. The equation: $3 = \frac{x}{x - 1}$ has solution

(a) $x = \frac{1}{3}$  (b) $x = \frac{2}{3}$  (c) $x = \frac{3}{2}$  (d) $x = \frac{5}{2}$  (e) None of these

16. If $x^2 + (y - 1)^2 = 25$ then $(x, y)$ must belong to

(a) a line that passes through (0,1)  (b) a circle with center (0,0) and radius 25  
(c) a circle with center (0,1) and radius 5  (d) circle with center (0,1) and radius 25  
(e) None of these

17. The solution set for the inequality: $\frac{x - 2}{x - 4} \leq 0$ is

(a) $x \leq 4$  (b) $x \geq 2$  (c) $2 \leq x \leq 4$  (d) $x \geq 4$ and $x \leq 2$  (e) None of these
18. The inverse of \[
\begin{bmatrix}
1 & -2 \\
2 & -6
\end{bmatrix}
\] is

a) \[
\begin{bmatrix}
-1 & -1/2 \\
-1/2 & -1/2
\end{bmatrix}
\] b) \[
\begin{bmatrix}
-1 & -1 \\
-1 & -1/2
\end{bmatrix}
\] c) \[
\begin{bmatrix}
-1 & 0 \\
-1 & -1/2
\end{bmatrix}
\] d) \[
\begin{bmatrix}
-1 & 0 \\
-1/2 & -1/2
\end{bmatrix}
\] e) None of these

19. The number of years will it take for a principal to double at an effective rate of 8% is

a. \[
\frac{\ln(1 + 0.08)}{\ln 2}
\] b. \[
\frac{\ln 2}{\ln(1.08)}
\] c. \[
\frac{\ln(1 + 0.08)}{\ln 2} \sqrt{2}
\] d. 8 years e) None of these

20. If \[
\begin{cases}
x + y - 3z = 5 \\
x - 3y + z = -7 \\
2x - y - 3z = 2
\end{cases}
\] then

a) x=3, y= -1, and z= 4
b) x=5, y= -8, and z= 12
c) x= 2 - 4z, y = -5+2z, and z = z
d) x=5-3z, y = 3 + 4z, and z=z
e) None of the above
Quantitative Skills Assessment at a Liberal Arts
College AUI as an Example
Business Students Test

Please circle only one answer. Please make every effort to answer the question after Logical thinking and use of acquired knowledge in the quantitative courses you took. Your contribution is very important to the future of quantitative skills at AUI. Thank you.

1. For a monopolist’s product, the cost function is $c(q) = 0.004q^3 + 20q + 5000$ and the demand function is $p = 450 - 4q$
Find the output $q$ that would maximize the profit.

2. If $\frac{dy}{dx} = e^{x^2} y^2$ and $y(-2) = -\frac{1}{2}$ then

   a) $y = e^{x^3} - \frac{1}{2}$  
   b) $y = e^{x^2} - \frac{1}{2}$  
   c) $\frac{e^{x^3} - 2}{2}$  
   d) $\frac{-1}{e^{x^2} + 1}$  
   e) None of the above

3. The exact area of the region bounded by the graphs of $y = x$ and $y = x^2$ is

   a) $1/6 \text{sq unit}$  
   b) $1/3 \text{sq unit}$  
   c) $1/2 \text{sq unit}$  
   d) $2/3 \text{sq unit}$  
   e) None of the above

4. $x^2 + xy + yz + z^2 = 6$, then $\frac{\delta z}{\delta y} =$

   a) $-\frac{x + 2z}{y}$  
   b) $-\frac{x + z}{2z}$  
   c) $-\frac{y + 3z}{y}$  
   d) $-\frac{x + 2z}{x + 2y}$  
   e) None of these

5. Let $f(x) = x^{4x+1}$ then $f'(x) =$

   a) $(2x + Lnx)x^{4x+1}$  
   b) $x^{4x+1}\left[\frac{4x + 1}{x} + 4Lnx\right]$  
   c) $\left[\frac{4x + 1}{x} + 4Lnx\right]$  
   d) $(4x + 1)x^{4x}$  
   e) None of these
6. A manufacturer of a product has a marginal revenue function given by \( \frac{dr}{dt} = 200 + 70q - 3q^2 \)

The demand function is given by:

a) \( p = \frac{70}{q} - 6 \)  

b) \( p = 70 - 6q \)  

c) \( p = 200q + 35q^2 - q^3 \)  

d) \( p = 200 + 35q - q^2 \)  

e) \( p = 200q + 35q^3 - q^4 \)  

f) None of the above

7. If

\[
\begin{align*}
x + y - 3z &= 5 \\
x - 3y + z &= -7 \\
2x - y - 3z &= 2
\end{align*}
\]

then

a) \( x = 3, y = -1, \) and \( z = 4 \)  

b) \( x = 5, y = -8, \) and \( z = 12 \)  

c) \( x = 2 - 4z, y = -5 + 2z, \) and \( z = z \)  

d) \( 5 - 3z, y = 3 + 4z, \) and \( z = z \)  

e) None of the above

8. A student must select two courses in the liberal arts and three courses in the social sciences.

There are six liberal arts courses and ten social sciences courses, all of which are different, from which

the student may choose. How many selections are possible?

a) 6 

b) 135 

c) 750 

d) 1800 

e) None of these

9. The winner of a contest may choose any two of six different prizes. How many choices are possible?

a) 15 

b) 20 

c) 25 

d) 30 

e) None of these

10. One Tuesday a store advertised a special sale for Wednesday. On Wednesday it was found that 60% of customers had known about the sale, and of these customers, 40% bought a sale item. Of the customers that had not known about the sale, 20% bought a sale item. If a customer bought a sale item, what is the probability that he or she had known about the sale?

a) \( \frac{3}{4} \)  

b) \( \frac{2}{3} \)  

c) \( \frac{11}{1} \)  

d) \( \frac{6}{7} \)  

e) None of these

11. Each question on a 10 questions multiple-choice examination has five choices, only one of which is correct. If a student answers each question in a random fashion, what is the probability that the student gets at least 8 questions correctly?
a- \( C_{10}^8 \left( \frac{1}{5} \right)^8 \left( \frac{4}{5} \right)^2 \)  

b- \( C_{10}^2 \left( \frac{1}{5} \right)^2 \left( \frac{4}{5} \right)^8 \)  

c- \( C_{10}^8 \left( \frac{1}{5} \right)^8 \left( \frac{4}{5} \right)^2 + C_{10}^9 \left( \frac{1}{5} \right)^9 \left( \frac{4}{5} \right)^1 + C_{10}^{10} \left( \frac{1}{5} \right)^{10} \)  

d- \( \left( \frac{1}{5} \right)^8 \)  

e. None of these

12. The number of years will it take for a principal to double at an effective rate of 8% is

a. \( \frac{\ln(1+0.08)}{\ln(2)} \)  
b. \( \frac{\ln(2)}{\ln(1.08)} \)  
c. \( \frac{\ln(1+0.08)}{\sqrt{2}} \)  
d. 8 years  
e. None of these

13. The inverse of \( \begin{bmatrix} 1 & -2 \\ 2 & -6 \end{bmatrix} \) is

a. \( \begin{bmatrix} -1-1/2 \\ -1-1/2 \end{bmatrix} \)  
b. \( \begin{bmatrix} -1-1 \\ -1-1/2 \end{bmatrix} \)  
c. \( \begin{bmatrix} -1-1/2 \\ -1 \end{bmatrix} \)  
d. \( \begin{bmatrix} -1 \\ 0 \end{bmatrix} \)  
e. None of these

14. If \( \log_2(x+1) = \log_2(x-1) + 1 \), then \( x \) equals

a) -4  
b) 2 and -2  
c) 1  
d) 3  
e) None of the above

15. At a restaurant a complete dinner consists of an appetizer, an entree, a dessert, and a beverage. The choices for the appetizer are soup or juice; for the entree the choices are chicken, fish, steak, or lamb; for dessert the choices are cherrie jubilee, fresh peach cobbler, chocolate truffle cake, or blueberry rolypoly; for the beverage, the choices are coffee, tea, or milk. How many complete dinners are possible?

a. 94  
b. 96  
c. 98  
d. 100  
e. None of these

16. A company manufactures three products: X, Y, and Z. Each product requires the use of machine time on machines A and B as given on the table below.

<table>
<thead>
<tr>
<th>Product</th>
<th>Machine A</th>
<th>Machine B</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1/5 hr</td>
<td>1/5 hr</td>
</tr>
<tr>
<td>Y</td>
<td>2/5 hr</td>
<td>1/5 hr</td>
</tr>
<tr>
<td>Z</td>
<td>2/5 hr</td>
<td>2/5 hr</td>
</tr>
</tbody>
</table>

The number of hours per day that A and B are available for production are 8 and 6 respectively. The profit per unit on X, Y, and Z is $10, $12 and $15 respectively. At least one unit of Z must be produced the next day. In order to maximize the profit generated by this company one would rather use
17. \( \int \frac{x^2 + 3x - 4}{x + 2} \, dx \) is
   a) \( \frac{x^2}{2} + 5x + 6 \ln|x + 2| + C \)
   b) \( \frac{x^2}{2} + x - 6 \ln|x + 2| + C \)
   c) \( \frac{1}{2} \ln|x + 2| + C \)
   d) \( \frac{(x^3 / 3) + (3x^2 / 2) - 4x}{(x^2 / 2) + 2x} + C \)
   e) None of the above

18. The monthly income of a group of 20,000 professional people is normally distributed with mean \( \mu = 8000 \text{MAD} \) and standard deviation \( \sigma = 2000 \text{MAD} \). What is the percentage of professionals from this group that has an income of less than 10,000 MAD?
   a) 68%  
   b) 84%  
   c) 99%  
   d) 100%  
   e) None of these

19. A landscaper earns 200 MAD per day when working and loses 40 MAD per day when not working. If the probability of working on any day is 4/7, find the landscaper expected daily earnings.
   a) \( \frac{800}{7} \)  
   b) \( \frac{120}{7} \)  
   c) \( \frac{680}{7} \)  
   d) \( \frac{160}{7} \)  
   e) None of these

20. Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?
   a) $16,000  
   b) $20,000  
   c) $15,000  
   d) $25,000  
   e) None of these
Appendix 2 Hypothesis Testing Questions

Humanities students are well prepared to take mathematics courses
Questions used to test this hypothesis:

- Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?
  a) $16,000  b) $20,000  c) $15,000  d) $25,000  e) None of these

- If \( x \) satisfies the inequality \(|x - 2| \leq 4\) then
  a) \( x \leq 6 \)  b) \( x \geq -2 \)  c) \(-2 \leq x \leq 6\)  d) \( x \geq 6 \)  e) None of these

- The equation: \( \frac{3}{x - 1} = \frac{x}{x} \) has solution
  a) \( x = \frac{1}{3} \)  b) \( x = \frac{2}{3} \)  c) \( x = \frac{3}{2} \)  d) \( x = \frac{5}{2} \)  e) None of these

- The solution set for the inequality: \( \frac{x - 2}{x - 4} \leq 0 \) is
  a) \( x \leq 4 \)  b) \( x \geq 2 \)  c) \( 2 \leq x \leq 4 \)  d) \( x \geq 4 \) and \( x \leq 2 \)  e) None of these

Humanities students take full advantage of their mathematics curriculum and can apply it to concrete situations.
Questions used to test this hypothesis were:

- The bureau of the census reports that the mean family income in United States is $40,000 with a standard deviation of $5000. We can safely infer that the percentage of families in the US that have an income less than $50,000 is about
  a) 68%  b) 84%  c) 99%  d) 34%  e) none of these

- The monthly income of a group of 20,000 professional people is normally distributed with mean \( \mu = 8000 \text{MAD} \) and standard deviation \( \sigma = 2000 \text{MAD} \). What is the percentage of professionals from this group that has an income of less than $10,000 MAD?
  a) 68%  b) 84%  c) 99%  d) 100%  e) none of these

- A landscaper earns 200 MAD per day when working and loses 40 MAD per day when not working. If the probability of working on any day is 4/7, find the landscaper’s expected daily earnings.
The winner of a contest may choose any two of six different prizes. How many choices are possible?

- a) 15  
- b) 20  
- c) 25  
- d) 30  
- e) 36

The table below gives the probability that X units of a company’s product is demanded weekly. Determine the expected weekly demand:

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(X = x)</td>
<td>0.05</td>
<td>0.20</td>
<td>0.40</td>
<td>0.24</td>
<td>0.10</td>
<td>0.01</td>
</tr>
</tbody>
</table>

- a) 1  
- b) 2  
- c) 2.71  
- d) 2.17  
- e) none of these

Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?

- a) $16,000  
- b) $20,000  
- c) $15,000  
- d) $25,000  
- e) None of these

At a restaurant a complete dinner consists of an appetizer, an entree, a dessert, and a beverage. The choices for the appetizer are soup or juice; for the entree the choices are chicken, fish, steak, or lamb; for the dessert the choices are cherrie jubilee, fresh peach cobbler, chocolate truffle cake, or blueberry rolypoly; for the beverage, the choices are coffee, tea, or milk. How many complete dinners are possible?

- a) 94  
- b) 96  
- c) 98  
- d) 100  
- e) None of these

The number of years will it take for a principal to double at an effective rate of 8% is

\[
\frac{\ln(1 + 0.08)}{\ln(2)} \quad \frac{\ln 2}{\ln(1.08)} \quad \frac{\ln(1 + 0.08)}{\ln 2} \sqrt{2}
\]

- a. \(\frac{\ln(1 + 0.08)}{\ln 2}\)  
- b. \(\frac{\ln 2}{\ln(1.08)}\)  
- c. \(\frac{\ln(1 + 0.08)}{\ln 2} \sqrt{2}\)  
- d. 8 years  
- e. None of these

**Humanities students can use data, analyze it and diagnose it.**

Questions used to test this hypothesis were

- For the following data sets \(A = \{1,3,4,2,7,6,8\}\) and \(B = \{1,3,4,2,7,2519,8\}\) the medians of the two different sets are
  - a. the same  
  - b. different  
  - c. almost the same  
  - d. don’t exist  
  - e. none of these

  \[
  \begin{align*}
  x + y - 3z &= 5 \\
  x - 3y + z &= -7 \\
  2x - y - 3z &= 2
  \end{align*}
  \]
  then

- a) \(x=3, y= -1, \text{ and } z= 4\)
b) \( x = 5, \ y = -8, \) and \( z = 12 \)
c) \( x = 2 - 4z, \ y = -5+2z, \) and \( z = z \)
d) \( x = 5-3z, \ y = 3 + 4z, \) and \( z = z \)
e) None of the above

- Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?
a) $16,000  b) $20,000  c) $15,000  d) $25,000  e) None of these

**Business students are well prepared to take mathematics courses**

Questions related to this hypothesis were:

- If \( \log_2(x + 1) = \log_2(x - 1) + 1 \), then \( x \) equals

a) \(-4\)  b) \(2\) and \(-2\)  c) \(1\)  d) \(3\)  e) None of the above

- Each question on a 10 questions multiple-choice examination has five choices, only one of which is correct. If a student answers each question in a random fashion, what is the probability that the student gets at least 8 questions correctly?

\[
C_{10}^8 \left(\frac{1}{5}\right)^8 \left(\frac{4}{5}\right)^2 + C_{10}^2 \left(\frac{1}{5}\right)^2 \left(\frac{4}{5}\right)^8 + C_{10}^9 \left(\frac{1}{5}\right)^9 \left(\frac{4}{5}\right)^1 + C_{10}^{10} \left(\frac{1}{5}\right)^{10}
\]

a) \(C_{10}^8 \left(\frac{1}{5}\right)^8 \left(\frac{4}{5}\right)^2\)  b) \(C_{10}^2 \left(\frac{1}{5}\right)^2 \left(\frac{4}{5}\right)^8\)  c) \((\frac{1}{5})^8\)

d) \(\frac{1}{5} \times (\frac{1}{5})^8\)  e) None of these

- The exact area of the region bounded by the graphs of \( y = x \) and \( y = x^2 \) is

a) \(1/6 \) sq unit  b) \(1/3 \) sq unit  c) \(1/2 \) sq unit  d) \(2/3 \) sq unit  e) None of the above

- If

\[
\begin{align*}
x + y - 3z &= 5 \\
x - 3y + z &= -7 \\
2x - y - 3z &= 2
\end{align*}
\]

then

a) \(x = 3, \ y = -1, \) and \( z = 4 \)
b) \(x = 5, \ y = -8, \) and \( z = 12 \)
c) \(x = 2 - 4z, \ y = -5+2z, \) and \( z = z \)
d) \(z = 5-3z, \ y = 3 + 4z, \) and \( z = z \)
e) None of the above
• The inverse of \[
\begin{bmatrix}
-2 & -6 \\
1 & 2
\end{bmatrix}
\] is

\[
\begin{bmatrix}
-1/2 & -1/2 \\
-1/2 & -1
\end{bmatrix}
\]

a) \[
\begin{bmatrix}
-1/2 & -1/2 \\
-1/2 & -1
\end{bmatrix}
\]  b) \[
\begin{bmatrix}
-1/2 & -1/2 \\
-1/2 & -1
\end{bmatrix}
\]  c) \[
\begin{bmatrix}
-1 & 1/2 \\
-1 & 0
\end{bmatrix}
\]  d) \[
\begin{bmatrix}
-1/2 & -1/2 \\
-1/2 & -1
\end{bmatrix}
\]  e) None of these

• Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?

a) $16,000  b) $20,000  c) $15,000  d) $25,000  e) None of these

**Business students take full advantage of their mathematics curriculum and can apply it to concrete situations.**

Questions related to this hypothesis were:

• For a monopolist’s product, the cost function is \(c(q) = 0.004q^3 + 20q + 5000\) and the demand function is \(p = 450 - 4q\). Find the output \(q\) that would maximize the profit.

a) 50  b) 6000  c) 450/4  d) 450  e) None of the above

• A manufacturer of a product has a marginal revenue function given by

\[
\frac{dr}{dq} = 200 + 70q - 3q^2
\]

The demand function is given by:

\[
p = \frac{70}{q} - 6
\]

a) \(p = \frac{70}{q} - 6\)  b) \(p = 70 - 6q\)  c) \(p = 200q + 35q^2 - q^3\)

d) \(p = 200 + 35q - q^2\)  e) \(p = 200q + 35q^3 - q^4\)  f) None of the above

• A student must select two courses in the liberal arts and three courses in the social sciences. There are six liberal arts courses and ten social sciences courses, all of which are different, from which the student may choose. How many selections are possible?

a) 6  b) 135  c) 750  d) 1800  e) None of these

• The winner of a contest may choose any two of six different prizes. How many choices are possible?

a) 15  b) 20  c) 25  d) 30  e) None of these
A company manufactures three products: X, Y, and Z. Each product requires the use of machine time on machines A and B as given on the table below.

<table>
<thead>
<tr>
<th></th>
<th>Machine A</th>
<th>Machine B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product X</td>
<td>1/5 hr</td>
<td>1/5 hr</td>
</tr>
<tr>
<td>Product Y</td>
<td>2/5 hr</td>
<td>1/5 hr</td>
</tr>
<tr>
<td>Product Z</td>
<td>2/5 hr</td>
<td>2/5 hr</td>
</tr>
</tbody>
</table>

The number of hours per day that A and B are available for production are 8 and 6 respectively. The profit per unit on X, Y, and Z is $10, $12 and $15 respectively. At least one unit of Z must be produced the next day. In order to maximize the profit generated by this company one would rather use

a) differentiation  b) integration  c) linear programming  d) simplex method  e) none of these

One Tuesday a store advertised a special sale for Wednesday. On Wednesday it was found that 60% of customers had known about the sale, and of these customers, 40% bought a sale item. Of the customers that had not known about the sale, 20% bought a sale item. If a customer bought a sale item, what is the probability that he or she had known about the sale?

a) 3/4  b) 2/3  c) 11/1  d) 6/7  e) None of these

The monthly income of a group of 20,000 professional people is normally distributed with mean $\mu = 8000$ MAD and standard deviation $\sigma = 2000$ MAD. What is the percentage of professionals from this group that has an income of less than 10000 MAD?

a) 68%  b) 84%  c) 99%  d) 100%  e) none of these

A landscaper earns 200 MAD per day when working and loses 40 MAD per day when not working. If the probability of working on any day is 4/7, find the landscaper’s expected daily earnings.

a) 800/7  b) 120/7  c) 680/7  d) 160/7  e) none of these

Three men bought a grocery store for $100,000. If the second man invested twice as much as the first and the third invested $20,000 more than the second, how much did the first man invest?

a) $16,000  b) $20,000  c) $15,000  d) $25,000  e) None of these

At a restaurant a complete dinner consists of an appetizer, an entree, a dessert, and a beverage. The choices for the appetizer are soup or juice; for the entree the choices are chicken, fish, steak, or lamb; for the dessert the choices are cherry jubilee, fresh peach cobbler, chocolate truffle cake, or blueberry rolypoly; for the beverage, the choices are coffee, tea, or milk. How many complete dinners are possible?
Engineering students are well prepared to take mathematics courses
Questions related to this hypothesis were:

- The series \( \sum_{n=1}^{\infty} \frac{1}{4^n} \)
  a) converges to 0  b) converges to 1  c) converges to \( \frac{1}{3} \)  d) diverges  e) converges, but not to any of these

- What is the GCD (greatest common divisor) of 18 and 60?
  a) 6  b) 9  c) 18  d) 1080  e) none of the above

- What is the LCM (least common multiple) of 18 and 60?
  a) 180  b) 6  c) 1080  d) 18  e) none of the above

- What is the negation of “if p, then q”?
  a) p and not q  b) if not p, then not q  c) not p and not q  d) (not p) and q  e) none of the above

- The inverse of \( \begin{bmatrix} 1 & -2 \\ 2 & -6 \end{bmatrix} \) is
  a) \( \begin{bmatrix} -1-1/2 \\ -1-1/2 \end{bmatrix} \)  b) \( \begin{bmatrix} -1-1 \\ -1-1/2 \end{bmatrix} \)  c) \( \begin{bmatrix} -1-1/2 \\ -1 \end{bmatrix} \)  d) \( \begin{bmatrix} -1-1/2 \\ -1 \end{bmatrix} \)  e) None of these

Engineering students can use acquired mathematical knowledge in concrete situations.
Questions related to this hypothesis were:

- Extensive experience with fans of a certain type used in diesel engines has suggested that the exponential distribution provides a good model for time until failure. Suppose the mean time until failure is 25,000 hours. What is the probability that a randomly selected fan will last at least 20,000 hours?
- The number of requests for assistance received by the helpdesk of AUI computer system is a Poisson process with rate $\alpha = 4$ per hour.  
Compute the probability that exactly 10 requests are received during a particular 2-hour period.

\[
\begin{align*}
a) \quad & \frac{4}{10}^{10} \quad b) \quad \frac{4}{10} \left( e^{-\frac{4}{10}} \right) \quad c) \quad \frac{8}{10} e^{-8} \quad d) \quad 2 \frac{4^{10}}{10!} e^{-4} \\
& \quad e) \quad None \ of \ these
\end{align*}
\]

- Suppose the force acting on a column that helps to support a building is normally distributed with mean 15.0 kips and standard deviation 2 kips. What is the probability that the force is between 13 and 17 kips?

\[
\begin{align*}
a) \quad & 0.4452 \quad b) \quad 0.9452 \quad c) \quad 0.68 \quad d) \quad 0.84 \quad e) \quad None \ of \ these
\end{align*}
\]

- The life of an electronic system is $Y = X_1 + X_2 + X_3 + X_4$, the sum of the subsystem component lives. The subsystems are independent, each having exponential failure densities with mean time between failures of 4 hours. In order to compute the probability that the system will operate at least 24 hours, you would you use

\[
\begin{align*}
a) \quad & \text{the binomial distribution} \quad b) \quad \text{the hyper-geometric distribution} \\
c) \quad & \text{the exponential distribution} \quad d) \quad \text{the gamma distribution} \quad e) \quad \text{None \ of \ these}
\end{align*}
\]

**Engineering students need in their curriculum or their research mathematical concepts and tools not addressed by current mathematics curriculum.**  
There was one question related to this hypothesis:

\[
\begin{align*}
A = \begin{pmatrix}
2 & 0 & 0 & 0 \\
0 & 3 & 0 & 0 \\
0 & 0 & 4 & 0 \\
0 & 0 & 0 & 1
\end{pmatrix}
\]

- Let vectors $u_1, u_2, u_3, u_4 \in \mathbb{R}$ and scalars $\lambda_1, \lambda_2, \lambda_3, \lambda_4 \in \mathbb{R}$ such that $f(u_i) = \lambda_i u_i$ for $i = 1, 2, 3, 4$.

\[
\begin{align*}
a) \quad & u_1 = (1,0,0,0), \quad u_2 = (0,1,0,0), \quad u_3 = (0,0,1,0), \quad u_4 = (0,0,0,1), \quad \lambda_1 = 2, \quad \lambda_2 = 3, \quad \lambda_3 = 3, \quad \lambda_4 = 1 \\
b) \quad & u_1 = (1,0,0,0), \quad u_2 = (0,1,0,0), \quad u_3 = (0,0,1,0), \quad u_4 = (0,0,0,1), \quad \lambda_1 = 1, \quad \lambda_2 = 1, \quad \lambda_3 = 1, \quad \lambda_4 = 1 \\
c) \quad & u_1 = (2,0,0,0), \quad u_2 = (0,3,0,0), \quad u_3 = (0,0,4,0), \quad u_4 = (0,0,0,1), \quad \lambda_1 = 1, \quad \lambda_2 = 1, \quad \lambda_3 = 1, \quad \lambda_4 = 1 
\end{align*}
\]
d) $u_1 = (2,0,0,0), u_2 = (0,3,0,0), u_3 = (0,0,4,0), u_4 = (0,0,0,1), \lambda_1 = 2, \lambda_2 = 3, \lambda_3 = 3, \lambda_4 = 1$

e) None of the above
Appendix   3  Questionnaires

SSE Students Questionnaire

This survey is aimed to assess the mathematical skills of AUI students, which would allow us to consolidate the strengths of basic quantitative courses and to figure out their weaknesses. We will be very thankful if you could answer the following questions:

1) How many hours per week would reserve for a mathematics class:
   a. Less than 3 hours   b. Around three hours   c. Around 6 hours   d. Around 9 hours

2) How many hours per week would you reserve for a non mathematics class:
   a. Less than 3 hours   b. Around three hours   c. Around 6 hours   d. Around 9 hours

3) When you are experiencing difficulties in a Mathematics class, you would rather link it to: (choose one answer)
   a. Language   b. Mathematics Phobia   c. Lack of preparation before coming to class
d. Lack of interest   e. Discrepancies between methods learned in high school and what is expected in college

4) How often do you seek some form of help (office hours, tutoring, asking questions in class)?
   a. Never   b. Sometimes   c. Most of the time   d. Always

5) How often do you take notes in a mathematics class?
   a. Never   b. I take notes of what the instructor says   c. I write whatever is on the black board
d. I try to take notes of everything that happens in class

6) How often do you participate in mathematics classes?
   a. Never   b. Sometimes   c. Most of the time   d. Always

7) How often do you use a calculator to compute an algebraic expression such as $f(4)$ where
   $$f(x) = \frac{125(x^2 + 9)(x^2 - 16)}{5(x + 4)\sqrt{x^2 + 9}}$$
   a. Never   b. Sometimes   c. Most of the time   d. Always

8) Does the English language affect your understanding of mathematical concepts?
   a. Never   b. Sometimes   c. Most of the time   d. Always

9) Do you think there should be preparatory mathematics classes offered by the University?
   a. Yes   b. No

10) Do you feel that students should take mathematics courses in successive semesters?
    a. Yes   b. No

11) Should the University offer Mathematics classes that cover different subjects than the currently offered ones?
    a. Yes   b. No

12) Do you think there are gaps between high school mathematics and the University required level?
    a. Yes   b. No
If Yes please specify one:

Thank You for Your Time
This survey is aimed to assess the mathematical skills of AUI students, which would allow us to consolidate the strengths of basic quantitative courses and to figure out their weaknesses. We will be very thankful if you could answer the following questions:

1) How many hours per week would reserve for a mathematics class:
a. Less than 3 hours  b. Around three hours  c. Around 6 hours  d. Around 9 hours

2) How many hours per week would you reserve for a non mathematics class:
a. Less than 3 hours  b. Around three hours  c. Around 6 hours  d. Around 9 hours

3) When you are experiencing difficulties in a Mathematics class, you would rather link it to: (choose one answer)
a. Language  b. Mathematics Phobia  c. Lack of preparation before coming to class  d. Lack of interest  e. Discrepancies between methods learned in high school and what is expected in college

4) How often do you seek some form of help (office hours, tutoring, asking questions in class)?
a. Never  b. Sometimes  c. Most of the time  d. Always

5) How often do you take notes in a mathematics class?
a. Never  b. I take notes of what the instructor says  c. I write whatever is on the black board  d. I try to take notes of everything that happens in class

6) How often do you participate in mathematics classes?
a. Never  b. Sometimes  c. Most of the time  d. Always

7) How often do you use a calculator to compute an algebraic expression such as \( f(4) \) where

\[
f(x) = \frac{125(x^2 + 9)(x^2 - 16)}{5(x + 4)\sqrt{x^2 + 9}}.
\]
a. Never  b. Sometimes  c. Most of the time  d. Always

8) Does the English language affect your understanding of mathematical concepts?
a. Never  b. Sometimes  c. Most of the time  d. Always

9) Do you think there should be preparatory mathematics classes offered by the University?
a. Yes  b. No

10) Should the University offer Mathematics classes that cover different subjects than the currently offered ones?
a. Yes  b. No

Thank You for Your Time
### 1. School of Humanities and Social Sciences

**Q1:** How many hours per week would reserve for a mathematics class?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 hours</td>
<td>1</td>
<td>10,0</td>
</tr>
<tr>
<td>Around three hours</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>Around six hours</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>Around nine hours</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>

**Q2:** How many hours per week would you reserve for a non math classes?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 hours</td>
<td>1</td>
<td>10,0</td>
</tr>
<tr>
<td>Around three hours</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Around six hours</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>Around nine hours</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>

**Q3:** When you experience difficulties in mathematics class, would you link this to:

<table>
<thead>
<tr>
<th>Mathematics phobia</th>
<th>Frequency</th>
<th>Percent</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of preparation before coming to class</td>
<td>3</td>
<td>30,0</td>
<td>40,0</td>
</tr>
<tr>
<td>Lack of interest</td>
<td>1</td>
<td>10,0</td>
<td>50,0</td>
</tr>
<tr>
<td>Discrepancies between methods learned in high school and what is expected in college</td>
<td>5</td>
<td>50,0</td>
<td>100,0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>100,0</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Q4:** How often do you seek some help? (office hours, tutoring, class questions)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sometimes</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>Most of the times</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>Always</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>

**Q5:** How often do you take notes in Mathematics classes?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>I take notes of what the instructor says</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>I write whatever is on the blackboard</td>
<td>5</td>
<td>50,0</td>
</tr>
<tr>
<td>I try to take notes of everything that happens in class</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>
Q6: How often do you participate in mathematics classes?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>Most of the time</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Always</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Q7: How often do you use a calculator to compute an algebraic expression?

\[ f(x) = \frac{125(x^2 + 9)(x^2 - 16)}{5(x + 4)\sqrt{x^2 + 9}} \]

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>1</td>
<td>10,0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Most of the times</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>Always</td>
<td>4</td>
<td>40,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Q8: Does the English affect your understanding of mathematical concepts?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>6</td>
<td>60,0</td>
</tr>
<tr>
<td>Most of the times</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Q9: Do you think there should be preparatory mathematics classes offered by the University?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>8</td>
<td>80,0</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>20,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Q10: Should the university offer mathematics classes that cover different subjects than the currently offered ones?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>7</td>
<td>70,0</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>30,0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100,0</td>
</tr>
</tbody>
</table>

2. School of Science and Engineering

Question 1: How many hours per week would reserve for a mathematics class:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 hours</td>
<td>1</td>
<td>7,7</td>
</tr>
<tr>
<td>Around three hours</td>
<td>6</td>
<td>46,2</td>
</tr>
<tr>
<td>Around 9 hours</td>
<td>6</td>
<td>46,2</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
</tr>
</tbody>
</table>
Question 2: How many hours per week would you reserve for a non mathematics class

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Around three hours</td>
<td>7</td>
<td>53,8</td>
<td>53,8</td>
</tr>
<tr>
<td>Around six hours</td>
<td>6</td>
<td>46,2</td>
<td>100,0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>

Q3: When you are experiencing difficulties in a Mathematics class, you would link it to:

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of preparation before coming to class</td>
<td>11</td>
<td>84,6</td>
<td>84,6</td>
</tr>
<tr>
<td>Discrepancies between methods learned in high school and what is expected in college</td>
<td>2</td>
<td>15,4</td>
<td>100,0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>

Q4: How often do you seek some form of help (office hours, tutoring, asking questions in class)?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>15,4</td>
<td>15,4</td>
</tr>
<tr>
<td>Sometimes</td>
<td>10</td>
<td>76,9</td>
<td>92,3</td>
</tr>
<tr>
<td>Most of the time</td>
<td>1</td>
<td>7,7</td>
<td>100,0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>

Q5: How often do you take notes in a mathematics class?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>15,4</td>
<td>15,4</td>
</tr>
<tr>
<td>I take notes of what the instructor says</td>
<td>6</td>
<td>46,2</td>
<td>61,5</td>
</tr>
<tr>
<td>I write whatever is on the black board</td>
<td>2</td>
<td>15,4</td>
<td>76,9</td>
</tr>
<tr>
<td>I try to take notes of everything that happens in class</td>
<td>3</td>
<td>23,1</td>
<td>100,0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>

Q6: How often do you participate in mathematics classes?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>6</td>
<td>46,2</td>
<td>46,2</td>
</tr>
<tr>
<td>Sometimes</td>
<td>6</td>
<td>46,2</td>
<td>92,3</td>
</tr>
<tr>
<td>Always</td>
<td>1</td>
<td>7,7</td>
<td>100,0</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>
Q7: How often do you use a calculator to compute an algebraic expression such as $f(4) = \frac{125(x^2 + 9)(x^2 - 16)}{5(x + 4)\sqrt{x^2 + 9}}$?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>6</td>
<td>46.2</td>
<td>46.2</td>
</tr>
<tr>
<td>Sometimes</td>
<td>3</td>
<td>23.1</td>
<td>69.2</td>
</tr>
<tr>
<td>Most of the time</td>
<td>2</td>
<td>15.4</td>
<td>84.6</td>
</tr>
<tr>
<td>Always</td>
<td>2</td>
<td>15.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Q8: Does the English language affect your understanding of mathematical concepts?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>7</td>
<td>53.8</td>
<td>53.8</td>
</tr>
<tr>
<td>Sometimes</td>
<td>6</td>
<td>46.2</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Q9: Do you think there should be preparatory mathematics classes offered by the University?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5</td>
<td>38.5</td>
<td>38.5</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>53.8</td>
<td>92.3</td>
</tr>
<tr>
<td>NA</td>
<td>1</td>
<td>7.7</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Q10: Do you feel that students should take mathematics courses in successive semesters?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11</td>
<td>84.6</td>
<td>84.6</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>15.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Q11: Should the University offer Mathematics classes that cover different subjects than the currently offered ones?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6</td>
<td>46.2</td>
<td>46.2</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>53.8</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Q12: Do you think there are gaps between high school mathematics and the University required level?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5</td>
<td>38.5</td>
<td>38.5</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>61.5</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>
3. School of Business Administration

Q1: How many hours per week would you reserve for a mathematics class?

<table>
<thead>
<tr>
<th>Hours</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Around three hours</td>
<td>4</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Around six hours</td>
<td>1</td>
<td>12.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Around nine hours</td>
<td>3</td>
<td>37.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Q2: How many hours per week would you reserve for a non mathematics class?

<table>
<thead>
<tr>
<th>Hours</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Around three hours</td>
<td>3</td>
<td>37.5</td>
<td>37.5</td>
</tr>
<tr>
<td>Around six hours</td>
<td>3</td>
<td>37.5</td>
<td>75.0</td>
</tr>
<tr>
<td>Around nine hours</td>
<td>1</td>
<td>12.5</td>
<td>87.5</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>12.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Q3: Difficulties in a Mathematics class is linked to:

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Phobia</td>
<td>1</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Lack of preparation before coming to class</td>
<td>5</td>
<td>62.5</td>
<td>75.0</td>
</tr>
<tr>
<td>Discrepancies between methods learned in high school and what is expected in college</td>
<td>2</td>
<td>25.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Q4: How often do you seek some form of help (office hours, tutoring, asking questions in class)?

<table>
<thead>
<tr>
<th>How often</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>1</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Sometimes</td>
<td>3</td>
<td>37.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Most of the time</td>
<td>3</td>
<td>37.5</td>
<td>87.5</td>
</tr>
<tr>
<td>Always</td>
<td>1</td>
<td>12.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Q5: How often do you take notes in a mathematics class?

<table>
<thead>
<tr>
<th>How often</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>1</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>I take notes of what the instructor says</td>
<td>5</td>
<td>62.5</td>
<td>75.0</td>
</tr>
<tr>
<td>I try to take notes of everything that happens in class</td>
<td>2</td>
<td>25.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
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</tr>
</tbody>
</table>
Q6: How often do you participate in mathematics classes?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sometimes</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Most of the time</td>
<td>6</td>
<td>75.0</td>
</tr>
<tr>
<td>Always</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Q7: How often do you use a calculator to compute an algebraic expression such as $f(4)$ where

$$f(x) = \frac{125(x^2 + 9)(x^2 - 16)}{5(x + 4)\sqrt{x^2 + 9}}$$

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Most of the time</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Always</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Q8: Does the English language affect your understanding of mathematical concepts?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>6</td>
<td>75.0</td>
</tr>
<tr>
<td>Total</td>
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<td>100.0</td>
</tr>
</tbody>
</table>

Q9: Do you think there should be preparatory mathematics classes offered by the University?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4</td>
<td>50.0</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>50.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Q10: Should the University offer Mathematics classes that cover different subjects than the currently offered ones?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4</td>
<td>50.0</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>