Quality multiple-choice exams without correction for guessing

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Centre of Expertise for Higher Education *(University of Antwerp)*

Starting in academic year 2021-2022, UAntwerp lecturers will be asked to use a higher pass mark for examinations with multiple-choice questions instead of correction for guessing.
You can consult the advisory text approved by the Education Board on Pintra (available to UAntwerp staff members after logging in), and if you use electronic multiple-choice exams, you can call on the expertise of e-campus (e-campus@uantwerpen.be) to implement the higher pass mark.

Multiple-choice questions, and especially the way they're scored to compensate for guessing, have been intensely debated in higher education in recent years. In exams with multiple-choice questions, measures should be taken to minimise the chances that students pass simply by guessing. For decades now, **correction for guessing** (i.e. deducting marks for wrong answers) has been the go-to solution for many lecturers. However, this system not only discourages guessing, but also causes great uncertainty among students. Even good students will be reluctant to answer questions when they're not 100% sure. Even worse is that it encourages (groups of) students to come up with 'creative' response strategies that have nothing to do with the actual learning content.

Fortunately, there are other ways to reduce the success rate of guessing one's way through a multiple-choice exam. In this Teaching Tip, we'll discuss the use of a **higher pass mark** as an alternative way to compensate for guessing. How does a higher pass mark work? What's the best cut-off point? And how do you calculate the students' final scores?

Finally, we'll discuss some **points of attention** to keep in mind when using multiple-choice questions: basing your exam on a testing matrix, adhering to the 'four eyes are better than two' principle, and being extremely careful when eliminating questions after an exam.

Higher pass mark vs. correction for guessing

In a **negative marking** system, guesswork is penalised by deducting marks for wrong answers, while questions left blank score zero.

In a system with a **higher pass mark**, wrong answers are not penalised: both questions left blank and wrong answers score zero. This encourages students to answer all questions and not leave any of them blank. The advantage here is that you can give the students clear and simple instructions. For example:

'You'll need to obtain a score of at least 60% to pass this exam. However, there's no penalty for incorrect answers, so be sure to answer all questions.'

Instead of spending time coming up with response strategies to 'minimise the damage', students can concentrate fully on demonstrating their knowledge and ability.

At Ghent University, where correction for guessing was abandoned in favour of a higher pass mark in 2015, the pass/fail rate has remained unchanged. However, the number of students with high marks (>14/20) has increased. When it comes to compensating for guessing, the higher pass mark turns out to be just as effective as negative marking (Lesage, E., et al., 2013, 2015).

Other research on multiple-choice exams (Baldiga, K., 2014; Cipriani, G.P., 2018; Mathysen, D.G.P. & Grupcheva, C., 2014) shows that on exams with negative marking, female students are more likely to leave questions unanswered than male students.

Setting a higher pass mark

The pass mark for an exam is the minimum total score needed to pass the exam. Unless explicitly mentioned otherwise, the standard pass mark is 50% of the maximum total score. However, in multiple-choice exams, a pass mark higher than half the maximum total score can be used as a way to neutralise the effect of getting some things right by guessing.

Statistically, a higher, **preferential pass mark** is just as effective as correction for guessing in mitigating the impact of guessing, but without the negative effect of making students overly uncertain, second-guessing themselves at every turn, agonising about whether to answer a question or leave it blank.

The best pass mark to use will depend on the number of possible answers to choose from. The more alternatives there are, the lower the chance of haphazardly picking the right one, so the pass mark to compensate for this will also be lower.

If every question has three possible answers to choose from, the (rounded) preferential pass mark is 67%. If there are four alternatives, it's 63%; for five alternatives, it's 60%.

For exams consisting of other question types than those with three, four or five alternatives, the following formula can be used to calculate the preferential pass mark (Ottoy, J.P. et al., 2016):

$$c = \sum_{i=1}^{X} \frac{m_i + 1}{2\, m_i}\, w_i$$

where c is the pass mark, X is the total number of questions, m_i is the number of possible answers to question i, and w_i is the weight assigned to question i (the default weight is 1).

When applying a higher pass mark, the students' 'raw' total scores must be converted to **'corrected' final scores** out of 20. This is done according to the following formula:

$$Final\ score\ =$$

$$S_{max} \times \frac{\left(\frac{S_{achieved}}{S_{max}} \times 100\right) - Min}{100 - Min}$$

where S_{max} is the highest achievable raw total score, $S_{achieved}$ is the achieved raw total score of an individual student, and the constant Min is determined by the following formula:

$$Min = 2 \times (c - 50)$$

where c is the cut-off used. The constant Min is a measure of the distance of this applied higher pass mark to the standard 50% pass mark.

It's important to **inform students properly and in a timely manner** (i.e. no later than at the start of the exam, but preferably in advance) of the higher pass mark.

Penalising 'fatal' answers

When assessing certain essential core competences or learning contents of a course, it may be advisable to consider the option of **combining a higher pass mark with a limited form of correction for guessing .**

This may be the case for multiple-choice questions where one of the alternatives is so wrong that selecting it not only demonstrates that the student hasn't mastered the relevant competence/learning content, but also constitutes a **danger or fundamental error** in the context of the course. In real-life situations, the answer could cause a serious accident or death, for instance.

Make sure to limit this type of question (no more than 20% of all questions) and to include only one 'fatal' alternative per question.

Quality multiple-choice questions

Besides reducing the success rate of pure guesswork, there are a few other points of attention to keep in mind when using multiple-choice questions: basing your exam on a testing matrix, adhering to the 'four eyes are better than two' principle, and being extremely careful when eliminating questions after an exam.

- **Base your exam on a testing matrix.** When preparing exams, it's important to have a clear view of the final competences for the course unit. A testing matrix can be a useful tool in this regard. It's a schematic representation of the final competences according to the underlying learning content on the one hand and the expected mastery level (knowledge, insight, application) on the other hand.

A testing matrix can help you to determine the nature of multiple-choice questions for a given exam: the percentages in the matrix indicate what percentage of the questions should relate to certain learning contents and/or a certain cognitive level.

> ***Example: introductory physics course***
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> *Suppose that the lecturer of an introductory physics course wants to create an exam consisting of 60 multiple-choice questions. The **sample testing matrix** (see **Table 1**) indicates that there should be 30 questions (50%) about classical field theory, 18 questions (30%) about electromagnetism and 12 questions (20%) about quantum mechanics.*
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> *However, the lecturer also has to take into account the level of the questions. **Table 2** shows a final **distribution of the questions** per subject and level, in accordance with the sample testing matrix.*

As far as the level of testing is concerned, it appears that when preparing multiple-choice questions, there's a tendency to focus on knowledge questions, because they're the easiest to come up with. This can be avoided by carefully observing the question percentage per level, as shown in the testing matrix.

Table 1. Example testing matrix for an introductory physics course

Subject	*Share of course*	*Knowledge*	*Insight*	*Application*	*Problem-solving*	*Total*
Classical field theory	50%	15%	15%	20%	0%	50%
Electromagnetism	30%	10%	10%	10%	0%	30%
Quantum mechanics	20%	5%	10%	5%	0%	20%
Total		30%	35%	35%	0%	100%

Table 2. Example distribution of multiple-choice questions for an introductory physics course

Subject	*Knowledge*	*Insight*	*Application*	*Problem-solving*	*Total questions*
Classical field theory	9	9	12	0	30
Electromagnetism	6	6	6	0	18
Quantum mechanics	3	6	3	0	12
Total questions	18	21	21	0	60

- **Adhere to the 'four eyes are better than two' principle.** Preparing quality multiple-choice questions can be difficult and time-consuming. After all, it takes a lot of thought and effort to come up with enough unambiguous questions that have one clear correct answer that isn't up for debate. ECHO Tip 38 in 'Fifty Teaching Tips' (ECHO, 2013; available online to UAntwerp staff) can help you make sure your multiple-choice questions are worded properly.

  Be sure to have all of your questions reviewed by at least one colleague.

  A fellow lecturer or assistant can help find unintentional ambiguities in your questions and answer alternatives, and check the exam for aspects such as spelling or layout.

  If there are any questions where the two of you don't fully agree on the correct answer or on different possible interpretations, these must be changed or removed entirely.

- **Be extremely careful when eliminating questions after an exam.** Analysing the answers to multiple-choice questions can give you insight into the quality of the questions and answer alternatives. ECHO Tip 40 in 'Fifty Teaching Tips' (ECHO, 2013; available online to UAntwerp staff) can help you with this.

  However, such analyses should really only be used to improve the quality of **future** multiple-choice exams.

  Only eliminate exam questions if absolutely necessary – e.g. if the question was not presented correctly to (some) students because of a technical problem – and then make sure that this elimination doesn't cause any student to be disadvantaged, i.e. to receive a lower score.

Summary

In this Teaching Tip, we discussed using a higher pass mark as an alternative to negative marking of multiple-choice exams to minimise the success rate of guessing. It's important to inform students properly and in a timely manner (i.e. no later than at the start of the exam, but preferably in advance) of the higher pass mark. When using a higher pass mark, the students' 'raw' total scores must be converted to 'corrected' final scores out of 20.

A testing matrix can help you to determine the nature of multiple-choice questions for a given test: the percentages in the matrix indicate what percentage of the questions should relate to certain learning contents and/or a certain cognitive level.

Be sure to have a colleague check your questions for accuracy, wording and other aspects beforehand. Never eliminate questions after the exam, unless absolutely necessary.

Want to know more?

Literature

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Teaching Tips (in Dutch)

- Meet wat u moet weten (ECHO Tip 19)
- ECHO publication 'Vijftig Onderwijstips' (available online to UAntwerp staff after logging in):
    - Tip 36: Inspiratie voor toetsvragen
    - Tip 37: Inschatten van de benodigde toetstijd
    - Tip 38: Opstellen van meerkeuzetoetsen
    - Tip 39: Meer dan kennis toetsen met meerkeuzetoetsen
    - Tip 40: Psychometrische tests bij meerkeuzetoetsen
- Thematische ECHO-tips m.b.t. toetsing
- BVdatabank - Meerkeuzevragen
- 4 tips voor het formuleren van meerkeuzevragen