

Case Study of STACK assessments in Maths for Economists

Lisa Feiste (University of Kassel) & Raphael Müller (University of Paderborn)

Project Leader:

Prof. Dr. Andreas Eichler (University of Kassel) + Prof. Dr. Michael Liebendörfer (University of Paderborn)

Cooperation partner for economics:

Apl. Prof. Dr. Rainer Voßkamp (University of Kassel) + Dr. Nadja Stroh-Maraun (University of Paderborn)

Agenda

- **Framework of STACK assessments**
 - Implementation and Differences
 - Content of exercises
- **Results**
 - Use of STACK Tasks – Participation + Scores
 - Relationships between the use of STACK tasks and motivation
 - STACK performance and exam results
- **Interpretation of findings**

Framework of STACK assessments Implementation and Differences



Target Group	Students of University of Paderborn and Kassel (mainly) first semester students
Lecture	Mathematics for economists
Setting	Voluntary and digital STACK exercises during the semester

University of Paderborn

University of Kassel

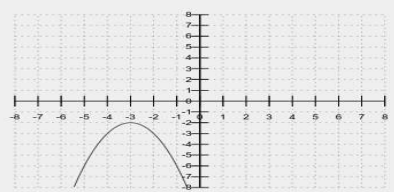
Lecture organization	3h per week + tutorials + voluntary digital tests	6h per week + tutorials + voluntary digital tests + additional offers → more workload per week
Number of tests	In total 7 tests in WS 23/24 (80% randomised STACK, 20% MC)	In total 13 tests in WS 23/24 (62% randomised STACK, 38% MC)
Duration	two weeks per test	weekly tests
Trails	Unlimited trials within two weeks	Unlimited trials* within one week
Incentives for students	bonus points for the exam (1 bonus point each for a maximum of 5/7 tests)	10% of the exam tasks will be tasks from the tests

Of these tests, three were almost **identical** for both universities on the topics of "Functions," "Derivatives," and "Integrals."

Framework of STACK assessments

Content of exercises

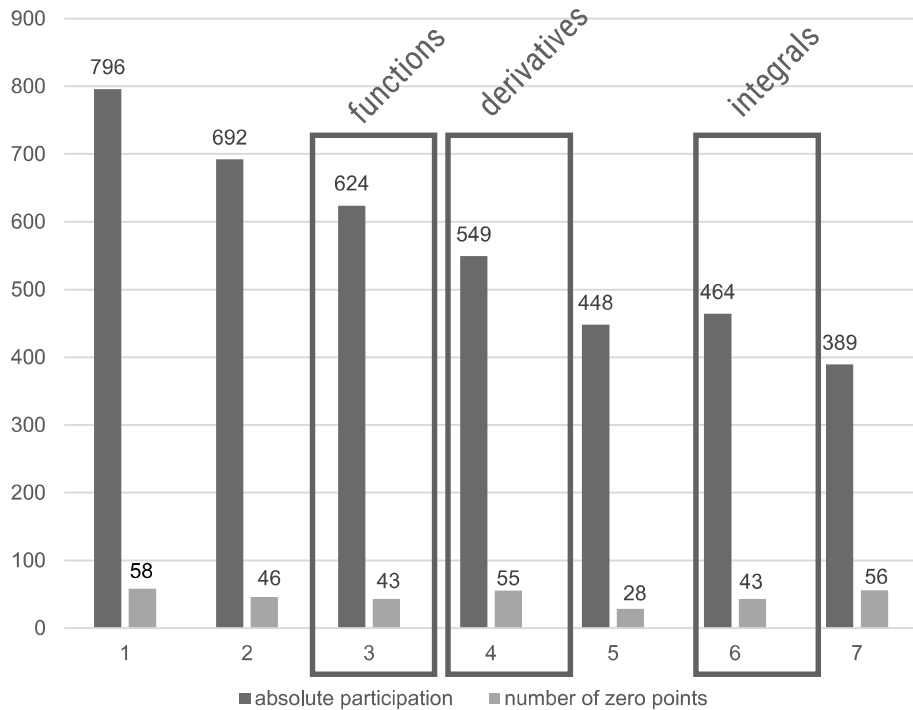


<ul style="list-style-type: none"> ➤ Test No. 3 ➤ „Functions“ 	<p style="text-align: center;">Test No. 4 „Derivation“</p>	<p style="text-align: center;">Test No. 5 „Integrals“</p>
<ul style="list-style-type: none"> ➤ Identical except for 3 additional application tasks in Paderborn ➤ Content: <ul style="list-style-type: none"> ➤ Enter value tables of quadratic or power functions ➤ Match function graphs ➤ Establish function rules for function graphs ➤ Test was perceived as appropriately difficult by the students 	<ul style="list-style-type: none"> ➤ Identical except for 2 application questions that were used in another test in Kassel ➤ Content <ul style="list-style-type: none"> ➤ Determine the derivative of functions ➤ Focused on various differentiation rules ➤ Test was perceived as very difficult by the students → also many input difficulties <p style="text-align: center;">"I couldn't enter my result correctly for question 8, unfortunately"</p>	<ul style="list-style-type: none"> ➤ Kassel: very low participation ➤ Significantly low participation in evaluation, very few comments ➤ Content: <ul style="list-style-type: none"> ➤ Determination of antiderivative functions ➤ Calculating the integral ➤ Determination of size of area under functions ➤ Difficulty level perceived as high, especially area under functions
 <p>Stellen Sie die Funktionsvorschrift des Funktionsgraphen auf.</p> <p><input type="text"/></p> <p>Eingabehinweise</p> <ul style="list-style-type: none"> • Geben Sie $a \cdot b$ als "a*b" ein. • Geben Sie $\frac{a}{b}$ als "a/b" ein. • Geben Sie \sqrt{a} als "sqrt(a)" ein. • Geben Sie Potenzen wie x^a als "x^a" und $(a + b)^c$ als "(a+b)^c" ein. 	<p style="text-align: right;">Es fehlen Tests oder Varianten.</p> <p>Bilden Sie die Ableitung der folgenden Funktion:</p> $f: \mathbb{R} \rightarrow \mathbb{R}, x \mapsto (-6 \cdot x + 7) \cdot (7 \cdot x - 2)$ <p>$f'(x) =$ <input type="text"/></p> <p>Eingabehinweise</p> <ul style="list-style-type: none"> • Eine Vereinfachung ist nicht nötig, sie kann aber die Eingabe vereinfachen. Das Ziel der Aufgabe ist es, die Ableitung richtig zu bilden. • Geben Sie $a \cdot b$ als "a*b" ein. • Geben Sie $\frac{a}{b}$ als "a/b" ein. • Geben Sie x^a als "x^a" ein. 	<p>Berechnen Sie das Integral:</p> $\int_3^5 (e^{-3 \cdot x} + 1) dx = $ <input type="text"/> <p>Eingabehinweis Bitte geben Sie die Lösung unter Verwendung der e-Funktion ein. Beispiel: $e^3 - e^6$ können Sie mittels "e^3-e^6" eingeben.</p> <p>Lösungshinweis zur Stammfunktion</p> <ol style="list-style-type: none"> 1) Das Integral lässt sich mit der Summenregel in zwei Einzelintegrale zerlegen. 2) Liegt ein konstanter Faktor vor, kann dieser aus einem Integral rausgezogen werden. 3) Ist die Potenz von e ein Produkt, kann es sinnvoll sein, dieses zu substituieren.

Use of STACK Tests – Participation per Test

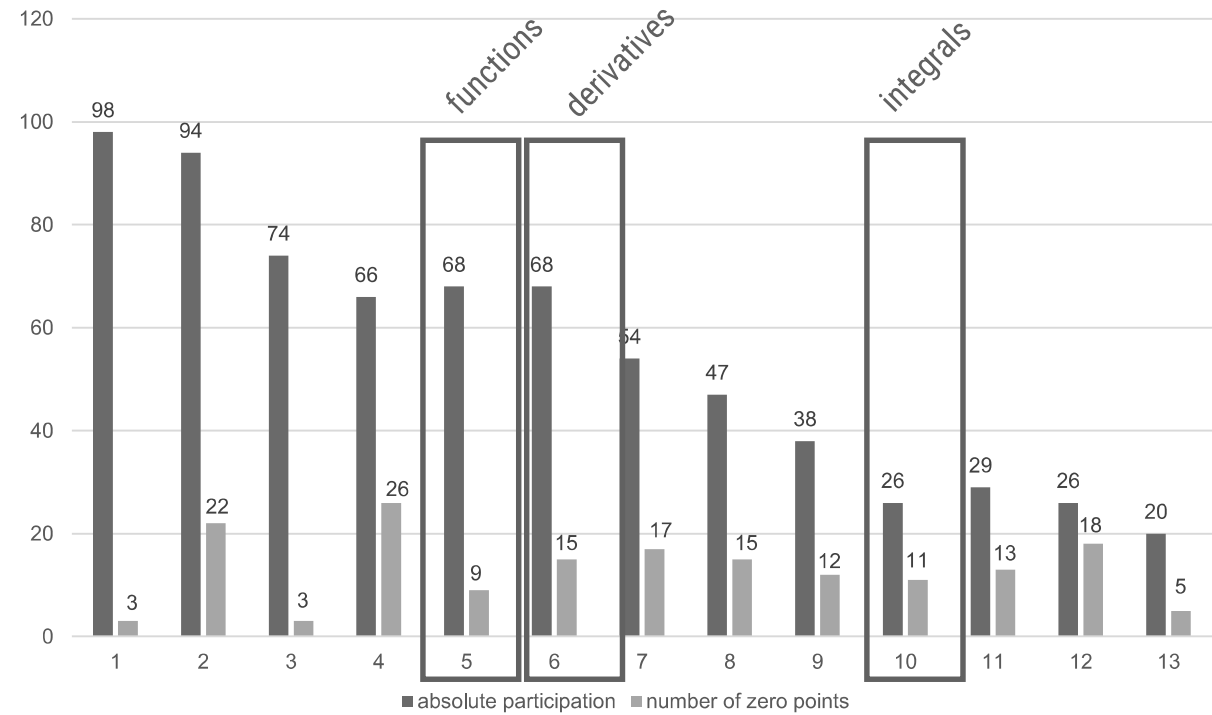
Paderborn

Number of Students per Test
(in total n=1.073 students)



Kassel

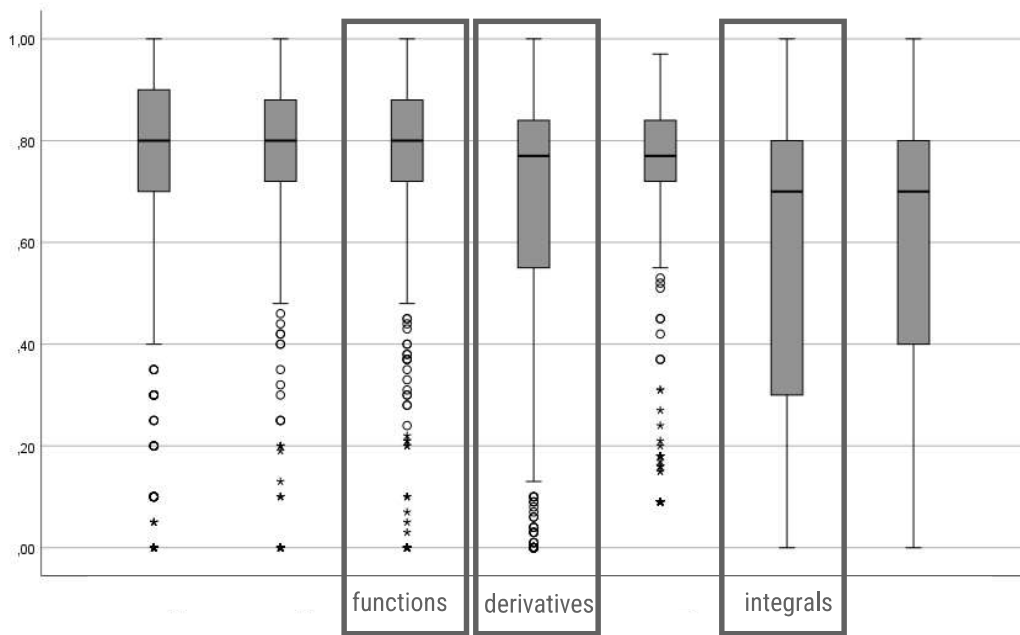
Number of Students per Test
(in total n=571 students)



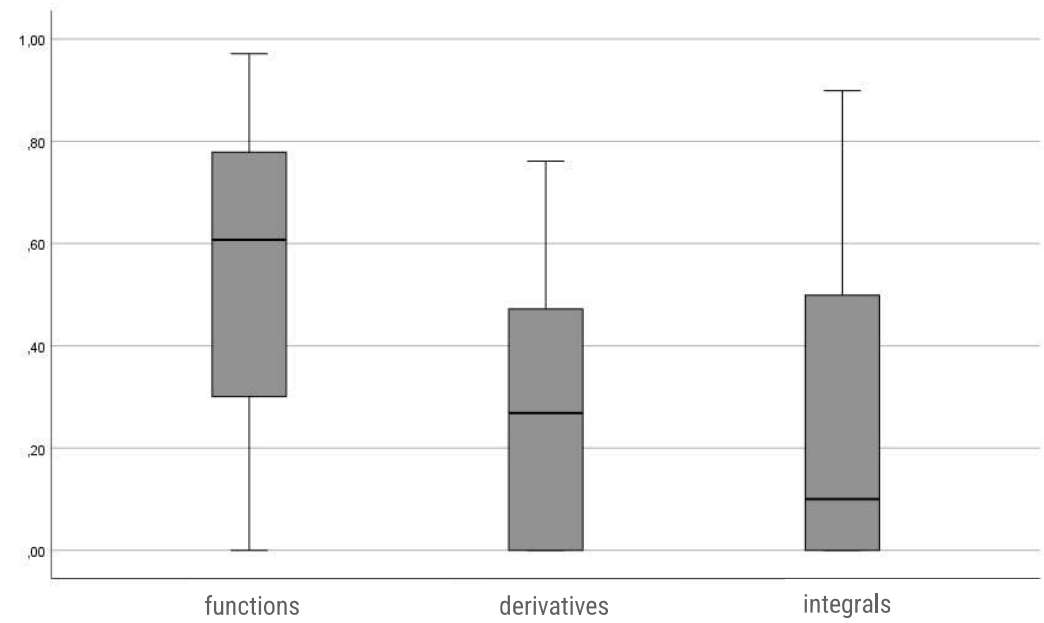
Use of STACK Tests – Scores (best attempt)



Paderborn

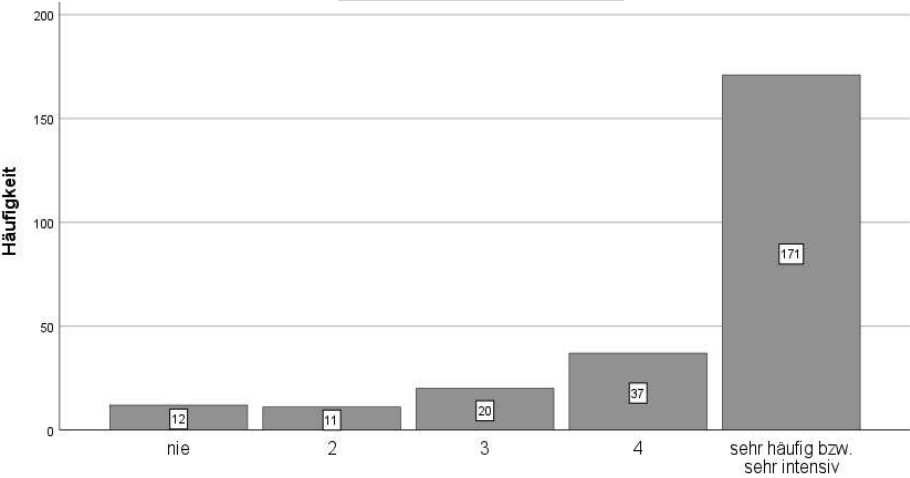


Kassel



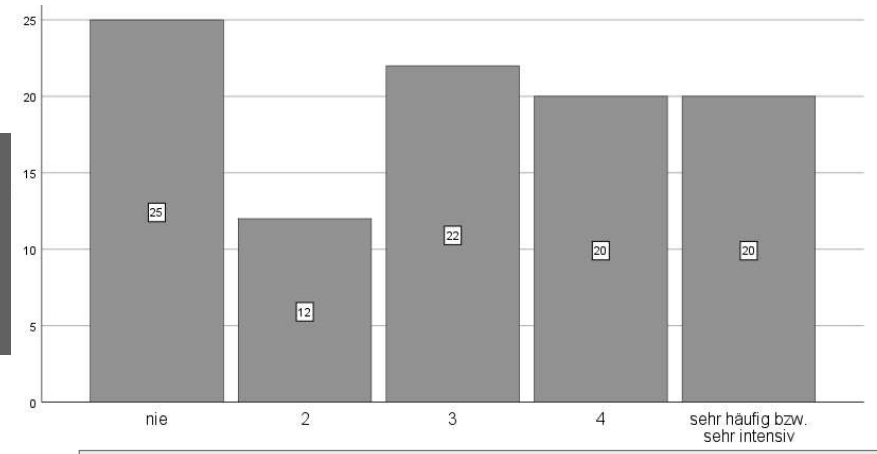
Relationships between the use of STACK tasks and motivation

Paderborn



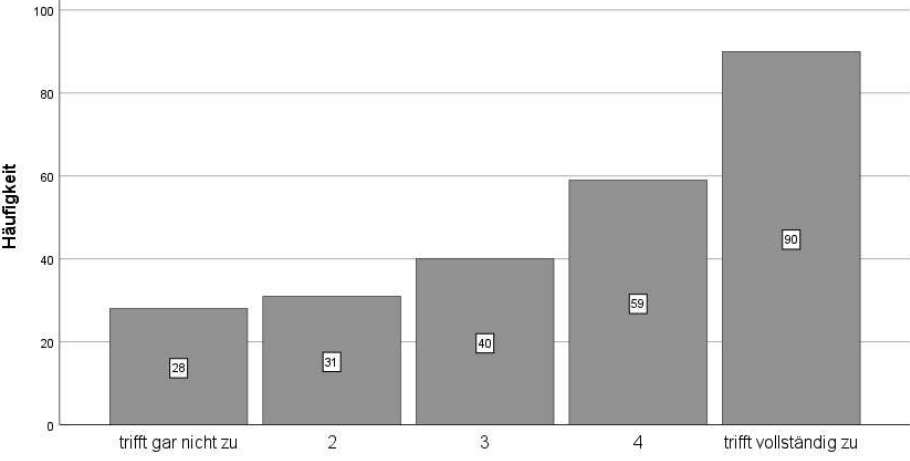
Participation in voluntary and digital STACK exercises

Kassel

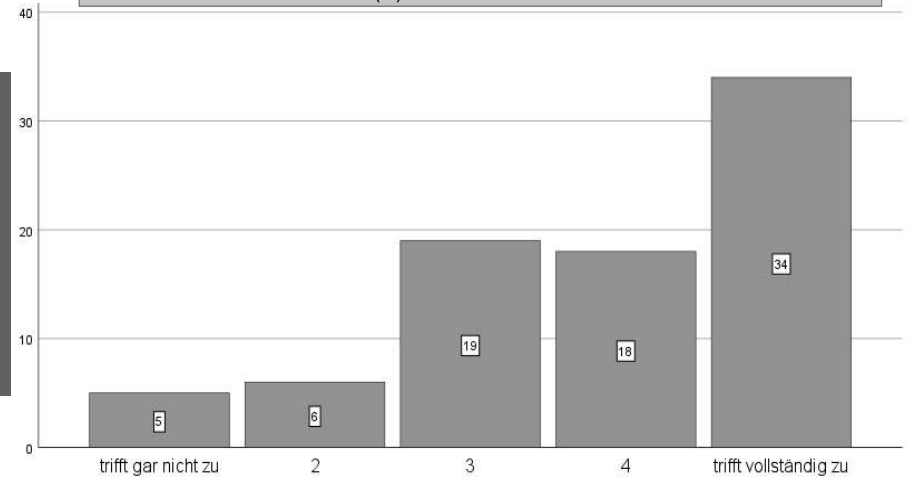


$r_{(PB)} = -0,197^{**}$ (n=248)

$r_{(K)} = 0,00$ (n=82)



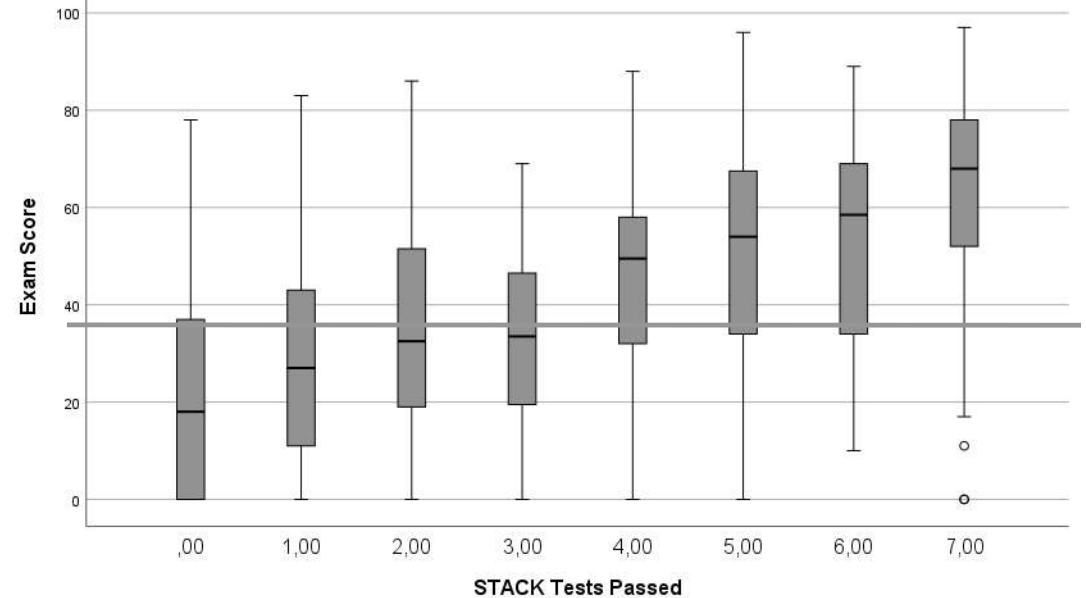
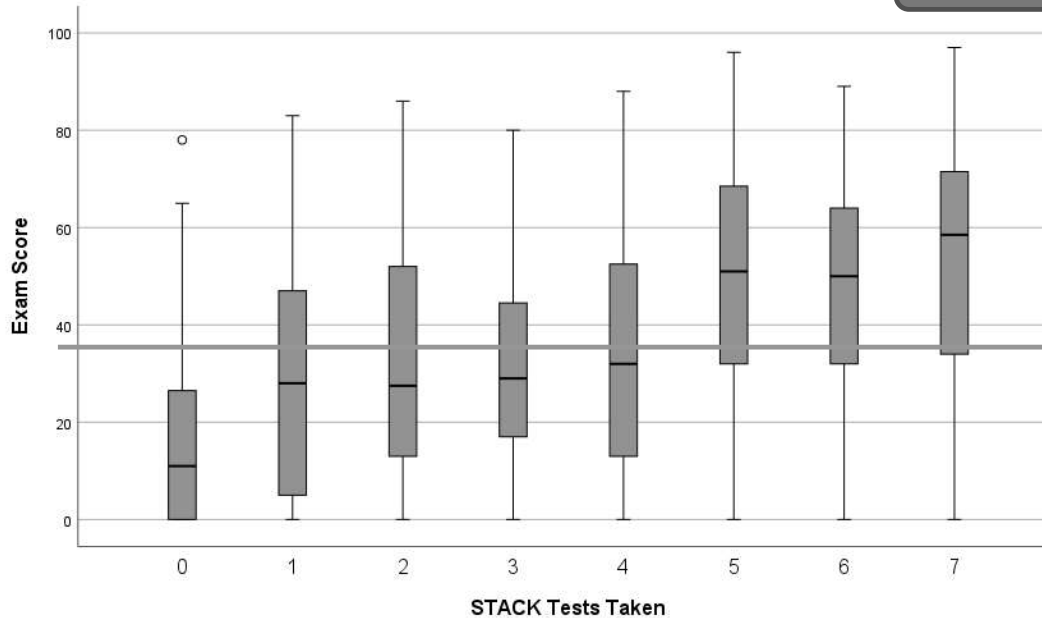
“My main goal for this event is to pass, the grade is secondary to me.”



STACK performance and exam results



Paderborn



Exam Score in Points, Max: 100 pts
Pass Mark: 37/100 pts

Results Regression model (average Exam Score), n=769
- STACK Tests taken $b=4,973$, $r^2=21,7\%$
- STACK Tests passed $b=5,692$, $r^2=28,2\%$



→ Exam performance by students taking at least 5 STACK tests significantly better (explaining 21% of variance)
→ Number of STACK tests passed even better predictor for exam scores (counted without bonus points), explaining 28% of variance

Interpretation of Findings

Paderborn

- High participation
- good scores (Test 1-5: On average above pass mark)
- Good balance between score and attempts

Interpretation:

Good incentives to train a task until one excels at it.

Kassel

- low participation (High loss due to extra moodle course (78%))
- worse scores → many times 0 points
- No correlation between task participation and studies' motivation

Interpretation:

Due to the abundance of options, students have difficulty making choices, so the incentive to seriously work on the tasks is lower.

Lehr-**L**ern-**V**erbünde **HD**
in mathematischen Studiengängen hochschulübergreifend
und digital

Thank you very much!

Literatur

Barbas, H.; Schramm, T.: The Hamburg Online Math Test MINTFIT for prospective Students of STEM Degree Programs. *MSOR Connections*, S. 43-51, 2018.

Hübl, R., Obermayr, D., Peterfi, M., & Weigel, M. (2023). 2. Digitale Fragetypen in der Mathematik: Einsatz des Fragetyps STACK an der DHBW Mannheim. *Digitale Lehre im Rahmen der Grundlagenausbildung in MINT-Fächern an Hochschulen*, 27.

Sangwin, C. (2013). *Computer Aided Assessment of Mathematics Using Stack*. Oxford: Oxford University Press.

Weigel, M., Hübl, R., Podgayetskaya, T. & Derr, K. (2018). Potential von STACK-Aufgaben im formativen eAssessment: Automatisiertes Feedback und Fehleranalyse. In Fachgruppe Didaktik der Mathematik der Universität Paderborn (Hrsg.), *Beiträge zum Mathematikunterricht* (S. 1419–1422). Münster: WTM.ter, S. 1185–1192.

Offizielle Webseite und Dokumentation STACK (zuletzt aufgerufen am 20. April 2024)
<https://stack-assessment.org/>