



eLearning exercises and tests

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Theme-based training of teaching staff for acquiring new teaching and learning methods

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Home exams for Hydraulics and Hydromechanics



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The figure displays 14 individual problem sheets arranged in two rows of seven. Each sheet is titled 'Aufgabe in Thema X' and includes a diagram and a list of questions. The sheets are numbered 1 through 14. The diagrams illustrate various hydraulic and hydromechanical scenarios, such as flow through pipes, open channels, and structures like weirs and gates. The questions typically ask for calculations of flow rates, pressures, and forces.

Fig.: 78 different problems

Home exams for Hydraulics and Hydromechanics



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Workflow

- ▶ submission
- ▶ ordering by problem
- ▶ evaluation and grading
- ▶ ordering by alphabet
- ▶ entering points into the system

Problems encountered

- ▶ high overhead
- ▶ time gap between submission and feedback
- ▶ students only get final points
- ▶ learning from mistakes difficult

The R/exams package: Zeileis et al. (2014)



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- ▶ code problems in R
- ▶ dynamic creation of:
 - ▶ online tests
 - ▶ written exams
 - ▶ solution sheets
- ▶ formatting based on \LaTeX and html



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<http://www.jstatsoft.org/>

Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond

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Abstract

The capabilities of the package `exams` for automatic generation of (statistical) exams in R are extended by adding support for learning management systems. As in earlier versions of the package exam generation is still based on separate `exams` files for each exercise – but rather than just producing different types of PDF output files, the package can now render the same exercises into a wide variety of output formats. These include HTML (with various options for displaying mathematical content) and XML specifications for online exams in learning management systems such as Moodle or OLAT. This flexibility is accomplished by a new modular and extensible design of the package that allows for reading all needed exercises into R and managing associated supplementary files (such as graphics or data files). The manuscript discusses the readily available user interface, the design of the underlying infrastructure, and how new functionality can be built on top of the existing tools.

Keywords: exams, e-learning, multiple choice, arithmetic problems, `swarm`, R, `RSTX`, HTML, XML, BMS QTI, Moodle, OLAT.

1. Introduction

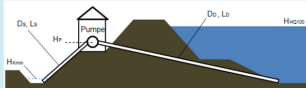
The design for version 1 of the `exams` package was conceived eight years ago (in 2006) when the original authors (Grett and Zeileis 2009) were involved in a redesign of the introductory statistics lecture at WU Wirtschaftsuniversität Wien. Back then the main goal was to be able to produce exams along with associated self-study materials as PDF (portable document format) files. Thus, the main focus was still on printable materials for classic classroom exams. Although a *classroom system* started to become available more easily back at that time, there

```
83 # # SOLUTION =====
84
85 # Saugleitung
86 Q <- QS
87
88 vS <- 4*Q/(dS*dS*pi)
89 ReS <- vS*dS/nu
90 epsilonS <- kb/dS
91
92 lambdaS <- lambdafkt(ReS,epsilonS)
93
94 IrS <- vS *vS / (2 * g) * lambdaS / dS
95 hrS <- IrS * LS
96
97 # Druckleitung
98
99 vD <- 4*Q/(dD*dD*pi)
100 ReD <- vD*dD/nu
101 epsilonD <- kb/dD
102
103 lambdaD <- lambdafkt(ReD,epsilonD)
104
105 IrD <- vD *vD / (2 * g) * lambdaD / dD
106 hrD <- IrD * LD
107
108
109 # manometrische Foerderhoehe und Foerdestrom
110
111 HPumpe <- H#Q100 - HKnin + hrS + hrD
112
```



- ▶ questions types
 - ▶ multiple / single choice
 - ▶ numeric
 - ▶ character string
- ▶ automated variation of values
- ▶ unlimited number of different assignments possible

Für eine Gemeinde wurde als Hochwasserschutzmaßnahme ein Deich errichtet. Dieser wurde auf ein 100-jähriges Hochwasser ausgelegt. Der prognostizierte Wasserstand bei diesem Hochwasser beträgt H_{100} . Da beim Deich ein Hochwasserfall Sickerwasser anfällt, muss dieses zurückgepumpt werden. Berechnungen ergaben, dass die Pumpe auf einen Förderstrom von mindestens Q_p ausgelegt werden muss. Der Ausschleisswasserspiegel im Drücksaal, bei dem die Pumpe abgeleitet wird, beträgt $H_{\text{Drucksaal}}$. Die Pumpenachse befindet sich in der Höhe H_p . Saugseitig ist eine Leitung mit dem Durchmesser D_s und der Länge L_s angeschlossen. Die Druckleitung hat einen Durchmesser D_d und eine Länge L_d . Die betriebliche Rauigkeit der Leitungen sind inklusive aller Armaturen mit k_s gegeben.



- Förderstrom: $Q_p = 13.5 \text{ l/s}$
- Nenn Durchmesser Saugleitung: DN80
- Länge Saugleitung: $L_s = 6.3 \text{ m}$
- Nenn Durchmesser Druckleitung: DN65
- Länge Druckleitung: $L_d = 19.4 \text{ m}$
- betriebliche Rauigkeit: $k_s = 0.15 \text{ mm}$
- Druck Atmosphärisch: $p_a = 101325 \text{ Pa}$
- Wasserstand Hochwasser: $H_{100} = 104.73 \text{ m s.s.l.}$
- Ausschleisswasserspiegel: $H_{\text{Drucksaal}} = 97.75 \text{ m s.s.l.}$
- Höhe Pumpenachse: $H_p = 101.84 \text{ m s.s.l.}$

Welche manometrische Förderhöhe in m muss die Pumpe im ungünstigsten Betriebszustand erbringen?	16,97	✓
Welche Pumpe aus dem beigelegten Pumpenkatalog muss für diese Anforderungen gewählt werden?	102001	✓
Welcher Laufraddurchmesser in mm muss für die Pumpe für diese Anforderungen gewählt werden?	230	✓
Welche Rohrkennlinie trifft zu?	B	✓
Welcher Förderstrom in m^3/s stellt sich im Betriebspunkt ein?	52	✓
Welche manometrische Förderhöhe in m stellt sich im Betriebspunkt ein?	18,7	✓
Welche erdberührende NPSH in m ist für diesen Betriebspunkt im Pumpenlager angegeben?	1,6	✓
Welcher Leistungsbedarf in kW besteht bei Betrieb der Pumpe am Betriebspunkt?	4,2	✓
Wie hoch ist die vorhandene Halbedruckhöhe $\text{NPSH}_{\text{erf}}, R=0$?	4,80	✓
Sicherheit gegen Kavitation ist ... (Sicherheitszuschlag: 0,5 m)	gegeben	✓

Potential of the



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Disadvantages

- ▶ only final results count
- ▶ easy to copy correct values
- ▶ no possibility to make students draw sketches
- ▶ initially high effort for coding

Advantages

- ▶ learning through several attempts
- ▶ individual assignment for each student
- ▶ saved time for correcting
- ▶ feedback straight after submission

Potential of the package

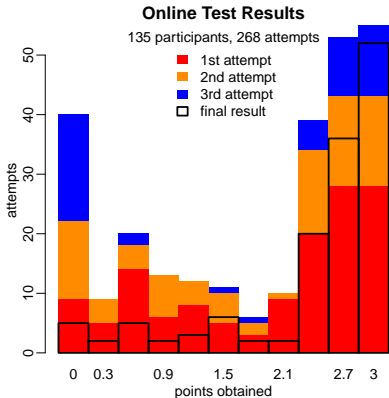


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- ▶ new problem for each attempt
- ▶ learning curve visible
- ▶ essentially > 2 points for third attempt
- ▶ students use third attempt for “testing”



Potential package

of the



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Submission days

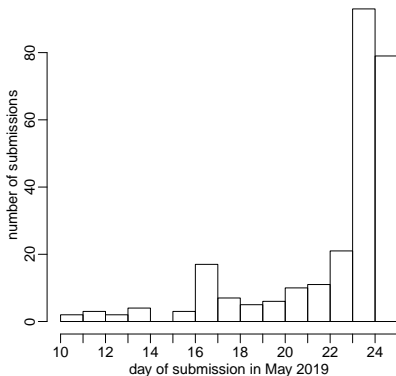


Fig.: Just in time!

Use of the package for offline tests



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- ▶ use package as questions data base
- ▶ export tests in pdf format
- ▶ automatic evaluation of multiple choice questions
- ▶ manual evaluation of open questions

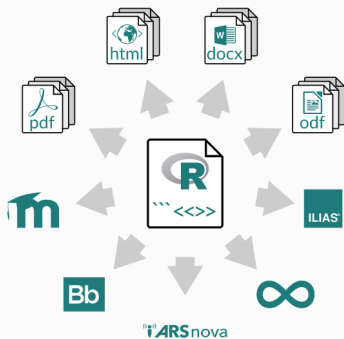


Fig.: source: *R/Exams* 2019
(<http://www.r-exams.org/>)



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References



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Zeileis, A., N. Umlauf and F. Leisch (2014). 'Flexible Generation of E-Learning Exams in R: Moodle Quizzes, OLAT Assessments, and Beyond'. *Journal of Statistical Software* 58 (1). DOI: 10.18637/jss.v058.i01.