Development of an Online-System for Assessing the Progress of Knowledge Acquisition in Psychology Students

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Abstract: Results of summative examinations represent most often only a snapshot of the knowledge of students over a part of the curriculum and do not provide valid information on whether a long-term retention of knowledge and knowledge growth takes place during the course of studies. Progress testing allows the repeated formative assessment of students' functional knowledge and consists of questions covering all domains of relevant knowledge from a given curriculum. This article describes the development and structure of an online platform for progress testing in psychology at the Witten/Herdecke University. The Progress Test Psychology (PTP) was developed in 2015 in the Department of Psychology and Psychotherapy at Witten/Herdecke University and consists of 100 confidence-weighted true-/false-items (sure / unsure / don't know). The Online-System for implementation of the PTP was developed based on XAMPP including an Apache Server, a MySQL-Database, PHP and JavaScript. First results of a longitudinal survey show the increase in student's knowledge in the course of studies also reliably reflects the course of the curriculum. Thus, content validity of the PTP could be confirmed. Apart from directly measuring the long-term retention of knowledge the use of the PTP in the admission of students applying for a Master's program is discussed.

1 INTRODUCTION

Learning and understanding of new educational content are major goals of academic teaching aiming at to expanding the student's knowledge base. Examination of these goals is mainly archived by practical, written or oral tests and other examination formats for the respective learning modules at the end of a course. Thus, the acquisition of knowledge of students is triggered to pass the exam (backwash effect), but may not be remembered in the long run (Leber et al., 2017). The knowledge curves of students in different topics confirm the approach of "assessment drives learning" according to Biggs (2003). Moreover, examination results only represent a snapshot of a special part of the complete curriculum and do not give valid information whether there is a long-term retention of knowledge over the course of the complete curriculum, as the content of this course is normally not tested again (Ferreira et al., 2016).

Educational research very early has given attention to this problem by conducting memory tests to assess retention of knowledge, i.e. in clinical psychology (Conway et al., 1991, 1997). One of the modern forms of assessing the retention of knowledge is given by progress testing developed in the 1990th at the University of Missouri-Kansas City School of Medicine and Maastricht University in the Netherlands (Nouns and Georg, 2010). A progress test is defined as a "repeated assessment of students' functional knowledge" (Schuwirth and van der Vleuten, 2012) and consists of questions covering all domains of relevant knowledge from a given curriculum. The blueprint of the progress test (PT) contains the full content of the curriculum, usually according to a classification matrix of relevant categories, e.g. organ systems and medical disciplines. An advantage of progress test is the fact that it is designed to test knowledge at graduate level, in a way that students after graduating should be able to complete the test on a 100 % level. In

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Germany progress tests are used as a means of formative, so-called low stakes assessment. With the increasing use of digital platforms in formative testing i.e. in mathematics (Faber et al., 2017) or engineering (Petrović et al., 2017), authors have also discussed the embedding of progress testing in a digital environment (Tio et al., 2016). Heenemann et al. (2017) found that the use of online progress test feedback by students through analysis of patterns, formulation, and follow-up of learning objectives is helpful for further learning. Also Schaap et al. (2011) were able to show that initial learning of psychology students is positively associated with good results in the progress test.

This article describes the development and the structure of an online platform for progress testing in psychology at Witten/Herdecke University and gives first insight in preliminary results.

2 MATERIAL AND METHODS

The Progress Test Psychology (PTP) was established for the first time German wide in 2015 in the Department of Psychology and Psychotherapy at Witten/Herdecke University and has become an integral part of the curriculums in the examination regulations for the Bachelor's Programme in Psychology and Psychotherapy (Dallüge et al., 2016). The modular curriculum for the bachelor program Psychology and Psychotherapy served as a blueprint for the test design with three methodological modules, six modules on the basics of psychology and four health-related modules. The weighting of the test questions corresponds in content to the weighting of all modules, so that the increase in knowledge reflects the actual course of the study.

The PTP consists of 100 items in single or multiple true-/false-format dealing with thematic statements from the modules of the curriculum. Answers are confidence-weighted (see Table 1) with sure (+2) or unsure (+1) to assess the cumulated knowledge of students on the cognitive and meta-cognitive level. Students can more easily decide if a statement is true if they can voice their possible doubts. In addition, rewarding the precise confidence assessment In addition, rewarding the accurate assessment of trust by doubling the achievable points directs students' attention to monitoring their knowledge, thus supporting self-directed learning. Moreover this construction reveals additional information on the impact of teaching and exams and allows for the reflexion of „not-knowing“ (Dutke and Barenberg, 2015).

Table 1: Scoring scheme using the example of a true hypothesis.

Answer	Points
True (sure)	2
True (unsure)	1
Don’t know	0
False (unsure)	-1
False (sure)	-2

The ePTP is implemented as a web-application which serves as the user interface and administers the access to the database. In our case there are two target groups or actors to be addressed: the most substantive part is essentially addressing the students as the main actors of the PTP. However the ePTP at least needs one administrator for implementing the tests. He or she (or a group of administrators) is responsible to select and release hypotheses and to create items relying on them. Moreover the administrator is responsible to implement, to lock or unlock the user profiles.

Profiles are stored in the database with the actual term of the student. Response time is an important indicator of whether students are seriously working on the progress test (Osterberg et al., 2006). Participants with a processing time of less than 15 minutes should be excluded from the calculation of the average values for feedback.

The administrator enables the students to access the ePTP. Once the ePTP is activated it can be completed by the student. After completion, the results can directly be accessed from the student and the administrator. In addition, the individual progress in knowledge acquisition a) within the course of time and b) compared to the complete group of students of the same term is presented using statistical routines implemented in the ePTP. This immediate feedback is a major benefit of the online PTP for the students’ further learning strategies. The resulting process flow is illustrated in Figure 1.

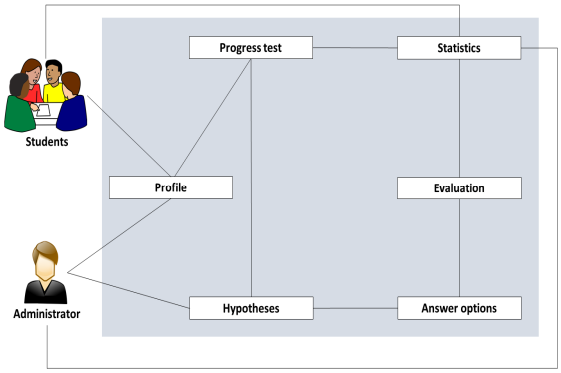

Figure 1: Process flow and responsibilities in the ePTP.

Thus, the following fundamental requirements have to be met by the web application of the database:

- Creation of a set of hypotheses
- Automatic Generion of the PTP
- Implementation of profiles and distribution of access rights
- Data acquisition: storage of the student responses
- Automated statistical analysis
- Graphical display of the results

3 RESULTS

3.1 Design and Implementation of the Database

The design of the database is based on the theory and pragmatics of the entity relationship models (Thalheim, 2013). A graphical visualization of the entity relationship model is given in Figures 2-4.

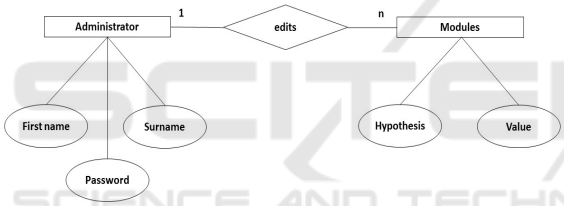

Figure 2: ER-Model describing the roles and responsibilities of the actors.

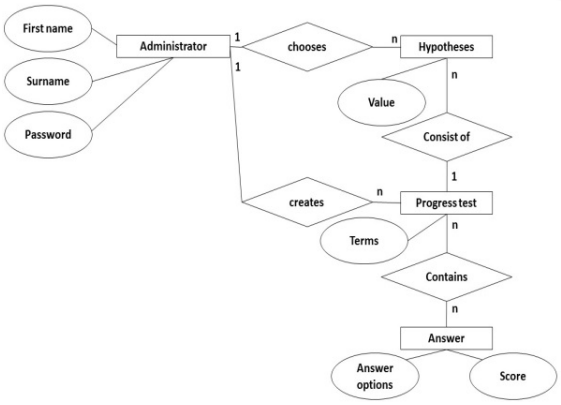

Figure 3: ER-Model describing the generation of the PTP.

The implementation of the PTP is based on the WINDOWs package XAMPP including an Apache Server, a MySQL-Database and PHP as the dialect of the framework. This framework has been used for web-based student record management systems (Walia and Gill, 2014). In addition JavaScript is used to react to the behaviour of the user by dynamically adaption of the web-interface.

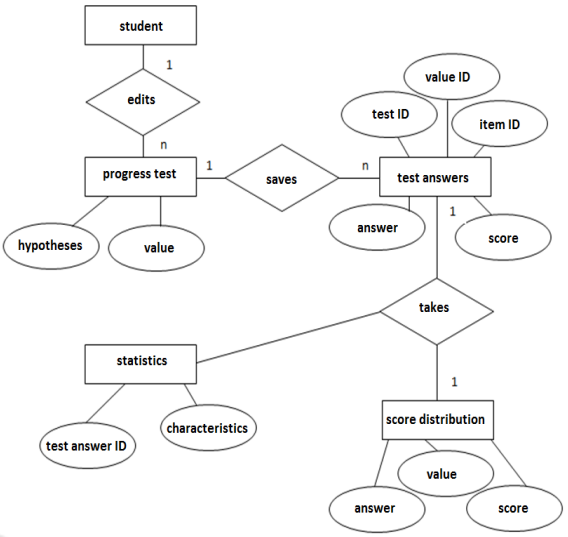

Figure 4: ER-Model for storing of processed hypotheses and statistical analysis.

3.2 First Statistical Results

Our database currently comprises complete time series from a total of four cohorts of students starting from summer 2015. Tables 2 and 3 describe the feedback given to a virtual student of the first semester.

Table 2: Scoring scheme using the example of a true hypothesis.

Participant-No. 666 – 1st semester of the Bachelor's Programme

		Own result	Mean value of the comparison group
Test score (correct – false)		14	**11.5**
True sure	(+2)	3 (1.5%)	**5.2** (**2.6**%)
True unsure	(+1)	15 (7.5%)	**11.3** (**5.6**%)
Don't know	(0)	78 (39.0%)	**78.6** (**39.3**%)
False unsure	(-1)	3 (1.5%)	**3.9** (**5.6**%)
False sure	(-2)	1 (0.5%)	**1.1** (**0.5**%)

You answered 22 out of 100 rated questions, thereof 82 % correct.

Your comparison group is the 1st semester with n=36 students.

Participant-No. 666 with a sum score of 14 (maximum 200 points) is just above the average of the comparison group. The extent of the "don't know" answers reflects the low level of prior knowledge at the beginning of the first semester.

Table 3: Evaluation sheet splitted by modules and compared to the peer group.

Modules	Items	Own result mean	%	Peer group mean	%
Methodological modules					
Introduction to Psychology	6	0	0.0	0.8	6.7
Statistics	15	2	6.7	1.3	4.3
Psychological Research Methods	6	-2	-16.7	1.0	8.1
Basic modules					
General Psychology	6	0	0.0	0.4	3.0
Biological Psychology	6	2	16.7	0.5	3.9
Social Psychology	6	1	8.3	1.6	13.6
Personality Psychology	6	2	16.7	1.0	8.6
Developmental Psychology	6	5	41.7	1.4	12.0
Educational Psychology	6	2	16.7	1.9	16.0
Health-related modules					
Psychological Diagnostics	6	0	0.0	0.2	1.6
Introduction of Clinical Psych.	15	3	10.0	3.0	10.0
Clinical Practice	10	1	5.0	2.4	11.8
Health Psychology	6	0	0.0	0.1	1.2

The results in the different modules clarify the focus of individual knowledge of Participant-No. 666. The module G-5 Developmental Psychology shows above-average knowledge, while the negative result (-2 points) in the module M-3 Psychological Research Methods suggests that the student was too convinced of their own knowledge and overestimated it.

Figure 4 describes the knowledge gain of one cohort from the initial assessment in the 1st semester (PTP 01: n=35) to the assessment in the 4th semester (PTP 04: n=29). As can been seen, there are highly significant (GLM repeated measures, α=5%, $p<0.0001$) differences in the knowledge gain in Statistics (1.6±1.9 vs. 5.8±4.5; F=24.5), Psychological Research Methodology (1.1±1.8 vs. 4.4±2.8; F=28.9), Biological Psychology (0.7±1.5 vs. 4.1±2.4; F=48.7) and Personality Psychology (1.4±1.9 vs. 4.3±3.7; F=16.3) to mention only some domains. Others like Health Psychology, Epidemiology and Public Health have not such accelerated increase in acquired knowledge (0.3±1.0 vs. 1.7±2.0; F=12.1), as the respective module is yet to come for this cohort in the sixth semester. Total PTP-Score also increased from 18.1±13.0 in the 1st semester to 47.9±20.2 in the 4th semester (F=49.3, $p<0.0001$). By proven construct validity (Zupanic et al., 2016) the internal consistency differs from very good (PTP 01: α=0.91) to acceptable (PTP 04: α=0.71).

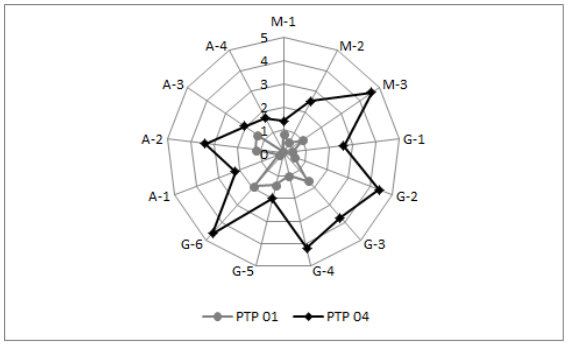

Figure 5: Knowledge gain from the 1st semester (PTP 01) to the 4th semester (PTP 04).
(M-1 Introduction to Psychology, M-2 Statistics, M-3 Psychological Research Methodology G-1 General Psychology G-2 Biological Psychology G-3 Social Psychology G-4 Personality Psychology G-5 Development Psychology G-6 Educational Psychology, A-1 Psychological Diagnostics, A-2 Introduction of Clinical Psychology, A-3 Clinical Practice, A-4 Health Psychology, Epidemiology and Public Health).

4 DISCUSSION

The PTP-Online system allows students to directly gain understanding in their overall knowledge acquisition as well as in their scores per discipline or module and to compare their score with the average in their respective peer group. Due to its low threshold as a formative assessment students get an unstressed feedback on their level of acquired knowledge which might also help to encourage students to fill their deficits.

The interest of the students in progress testing resp. in the feedback on the individual current state of knowledge depends on whether they are motivated to close the gap to the possible level of knowledge. This approach corresponds to a constructivist perspective of learning that, given the prerequisite of self-reflection and evaluation, considers a strong involvement of students in the learning process to be essential (Rushton, 2005).

Starting from the job description of a psychologist resp. from the expected knowledge of a bachelor in psychology, a standardized test was developed on the basis of a blueprint, which validates the learning progress (s. figure 6). As a measure of internal quality assurance, the lecturers also receive feedback on the average knowledge growth in the semesters.

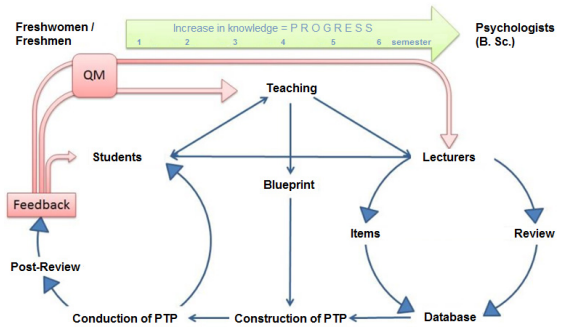

Figure 6: Integration of the PTP into the process of knowledge gaining of the students (adapted from Siegling-Vlitakis et al.; 2014; p. 1078).

Furthermore, studies of psychological assessment in psychology students have shown equivalence of paper-pencil and online tests (Vallejo et al., 2007). However there is a clear dominance of online testing with respect to usability and completeness of data (Kongsved et al., 2007). Schüttpelz-Brauns et al. (2018) found fewer non-responders in a paper-based format than in an online format, like several studies before, which might depend on a survey fatigue in the context of online surveys.

With respect to other scientific disciplines, progress testing has also been applied in the field of information literacy (de Meulemeester and Buysse, 2014), language acquisition (Becker et al., 2017) and basic law science (Moravec et al., 2015). In particular in the study of Moravec et al. it was found that a provision of an E-learning tool increased the average correctness of answers at the test by around 20%.

Further research thus should be carried out to evaluate paper-pencil vs. online progress testing concerning the reliability of the PTP.

5 CONCLUSION

Apart from assessing the acquired knowledge in the course of a Bachelor programme, the PTP might also be useful as a tool to measure the knowledge acquisition of graduated students applying for a Master's program. Moreover it can be applied as a "policy tool to introduce meaningful curricular adjustment" (Becker et al., 2017) aiming at optimizing the quality of higher education (Khalil et al., 2017).

REFERENCES

A. Becker, T. Nekrasova-Beker, T. Petrashova (2017). Testing as a Way to Monitor English as a Foreign Language Learning. *TESL-EJ, 21(2)*.

J. Biggs (2003). Teaching for quality learning at university. *The Society for Research into Higher Education and Open University Press, Buckingham*.

M. A. Conway, G. Cohen, N. Stanhope (1991). On the very long-term retention of knowledge acquired through formal education: Twelve years of cognitive psychology. *Journal of Experimental Psychology: General, 120(4), 395-409*.

M. A. Conway, J. M. Gardiner, T. J. Perfect, S. J. Anderson, G.M. Cohen (1997). Changes in memory awareness during learning: the acquisition of knowledge by psychology undergraduates. *Journal of Experimental Psychology: General, 126(4), 393-413*.

E. Dallüge, M. Zupanic, C. Hetfeld, M. Hofmann (2016). Wie bildet sich das Curriculum des Studiums im Progress Test Psychologie (PTP) ab? In: M. Krämer, S. Preiser, K. Brusdeylins (Eds). *Psychologiedidaktik und Evaluation XI. Aachen: Shaker, 307-314*.

A. de Meulemeester, H. Buysse (2014). Progress testing of information literacy versus information literacy self-efficacy in medical students. *European Conference on Information Literacy, Springer, New York: 361-369*.

S. Dutke, J. Barenberg (2015). Easy and Informative: Using Confidence-Weighted True–False Items for Knowledge Tests in Psychology Courses. *Psychology Learning & Teaching, 14(3), 250-259*.

J. M. Faber, H. Luyten, A. J. Visscher (2017). The effects of a digital formative assessment tool on mathematics achievement and student motivation: Results of a randomized experiment. *Computers & education, 106, 83-96*.

J. J. Ferreira, L. Maguta, A. B. Chissaca, I. F. Jussa, S. S. Abudo (2016). Cohort study to evaluate the assimilation and retention of knowledge after theoretical test in undergraduate health science. *Porto Biomedical Journal, 1(5), 181-185*.

S. Heeneman, S. Schut, J. Donkers, C. P. M. van der Vleuten, A. Muijtjens (2017). Embedding of the progress test in an assessment program designed according to the principles of programmatic assessment. *Med Teach. 39:44-52*.

M. K. Khalil, H. G. Hawkins, L. M. Crespo, J. Buggy (2017). The Design and Development of Prediction Models for Maximizing Students' *Academic Achievement. Medical Science Educator, 1-7*.

S. M. Kongsved, M. Basnov, K. Holm-Christensen, N. H. Hjollund (2007). Response rate and completeness of questionnaires: a randomized study of Internet versus paper-and-pencil versions. *J Med Internet Res, 9(3):e25*.

J. Leber, A. Renkl, M. Nückles, K. Wäschle (2017). When the type of assessment counteracts teaching for understanding. *Learning: Research and Practice, 3, 1-19*.

T. Moravec, P. Štěpánek, P. Valenta (2015). The influence of using e-learning tools on the results of students at the tests. *Procedia-Social and Behavioral Sciences, 176, 81-86*.

Z. M. Nouns, W. Georg (2010). Progress testing in

German speaking countries. *Medical teacher, 32(6), 467-470*.

K. Osterberg, S. Kölbel, K. Brauns (2006). Berlin Progress Test: Experiences at the Charité Berlin. *GMS Z Med Ausbild. 23:Doc46.*

J. Petrović, P. Pale, B. Jeren (2017). Online formative assessments in a digital signal processing course: Effects of feedback type and content difficulty on students learning achievements. *Education and Information Technologies, 22, 1-15*.

A. Rushton (2005). Formative assessment: a key to deep learning? *Med Teach. 27:509-13*.

C. Siegling-Vlitakis, S. Birk, A. Kröger, C. Matenaers, C. Beitz-Radzio, C. Staszyk, S. Arnhold, B. Pfeiffer-Morhenn, T. Vahlenkamp, C. Mülling, E. Bergsmann, C. Gruber, P. Stucki, M. Schönmann, Z. Nouns, S. Schauber, S. Schubert, J. P. Ehlers (2014). *PTT: Progress Test Tiermedizin - Ein individuelles Feedback-Werkzeug für Studierende. Deutsches Tierärzteblatt 8/2014, 1076-1082*.

L. Schaap, H. G. Schmidt, P. J. L. Verkoeijen (2011). Assessing knowledge growth in a psychology curriculum: which students improve most? *Assess Eval Higher Educ, 1-13*.

K. Schüttpelz-Brauns, M. Kadmon, C. Kiessling, Y. Karay, M. Gestmann, J.E. Kämmer (2018). Identifying low test-taking effort during low-stakes tests with the new Test-taking Effort Short Scale (TESS) – development and psychometrics. *BMC Medical Education 201818:101*.

L. W. T. Schuwirth, C. P. M. van der Vleuten (2012). The use of progress testing. *Perspectives on Medical Education 6(1):24-30*.

B. Thalheim (2013). Entity-relationship modeling: foundations of database technology. *Springer Science & Business Media*.

R. A. Tio, B. Schutte, A. A. Meiboom, J. Greidanus, E. A. Dubois, A. J. Bremers (2016). The progress test of medicine: the Dutch experience. *Perspectives on medical education, 5(1), 51-55*.

E. S. Walia, E. S. Gill (2014). A framework for web based student record management system using PHP. *International Journal of Computer Science and Mobile Computing, 3(8), 24-33*.

M. A. Vallejo, C. M. Jordán, M. I. Díaz, M. I. Comeche, J. Ortega (2007). Psychological assessment via the internet: a reliability and validity study of online (vs paper-and-pencil) versions of the General Health Questionnaire-28 (GHQ-28) and the Symptoms Check-List-90-Revised (SCL-90-R). *J Med Internet Res, 9(1):e2*.

M. Zupanic, J. P. Ehlers, T. Ostermann, M. Hofmann (2016). Progress Test Psychologie (PTP) und Wissensentwicklung im Studienverlauf. In: *M. Krämer, S. Preiser, K. Brusdeylins (Eds). Psychologiedidaktik und Evaluation XI. Aachen: Shaker, 315-322*.