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Assessing learning achievement, time effort, learning approaches and tempo during learning within the experiment-based behavioral task LAsO – reliability and incremental validity

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Abstract

The assessment of aspects of learning potential like learning achievement and approaches in our days of life long learning is interesting for an appraisal of aptitude and the identification of *high-* and *low-potentials*. Due to the reported problems concerning the predictive validity of common instruments, we used the new experiment-based behavioral task LAsO for an assessment of *learning achievement, time effort, learning approaches* and *tempo during learning* based on a micro analytic action research. We analysed reliability and incremental validity on a sample of 322 apprentices. Beneath the valuated *behavior* by the formation team and a short scale for *conscientiousness*, the integration of the LAsO-scores into two block binary logistic regression analyses revealed, that the LAsO-scores are significant predictors for *high-* and *low-potentials* and therefore provide increment predictive validity.

Key words: personnel selection; learning achievement and approaches; experiment-based behavioral task; incremental validity

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1. Introduction

The assessment of learning potential and approaches during learning is not only important in educational school context (e.g. PISA, Artelt, Baumert, McElvany & Peschar, 2003) for the development and application of proper trainings, but seems also be of interest for an appraisal of aptitude and the identification of *high-* and *low-potentials* in context of industrial-organizational psychology. Nowadays job rotation and the need of constant development of key personnel request life long learning from everybody. That is why it seems reasonable that the learning potential itself should predict real life criteria like both school and work performance. Therefore the assessment of *learning achievement, time effort, learning approaches* and *tempo during learning* is important to be analysed in different fields of research and areas of application.

1.1 Reported problems with common instruments as predictors for school and work performance

Beside the quite complex and time-consuming methods (Bannert, 2004) like *daily diaries* (e.g. Perels, Otto, Landmann, Hertel & Schmitz, 2007), *think aloud protocols*, *learning journals*, *interviews* (e.g. with the Self-Regulated Learning Interview Schedule: SRLIS; Zimmerman & Martinez-Pons, 1986) and *assessment centres* (e.g. Sarges, 2001), the most common, but rather problematic way of assessing individual learning potential and approaches are questionnaires. As it seems that learning style literature has provided mostly insights into what students typically say they do when presented with learning material (Boekaerts, 1999), there are several questionnaires in use: The most common ones in the Anglo-American areas are the *Motivated strategies for learning questionnaire* (MSLQ; Pintrich, Smith & McKeachie, 1989) and the *Learning and Study Strategies Inventory* (LASSI; Weinstein, Palmer & Schulte, 1987; Weinstein, 1988) and in German areas the *Questionnaire for measuring learning strategies of students* (Wild & Schiefele, 1994) and the *Inventory for learning strategies from Kiel* (Baumert, Heyn & Köller, 1992). All of them analyse specific aspects concerning the *learning potential and approaches* like *cognitive strategies* (e.g. rehearsal, elaboration, organization, and critical thinking), *metacognitive strategies* (e.g. planning, monitoring, and regulating strategies), *and internal and external resource management strategies* (e.g. managing time and study environment; effort, peer learning and help-seeking). Even though the number of empirical studies basing on intro- and retrospective analysis of learning approaches is enormous, there seems to exist the problem of disappointingly low correlations between the reported learning styles and the grade-point average of school performance (cf. Artelt 2006; Baumert & Köller, 1996). One obvious reason for Boekaerts (1999) for the difficulties with common instruments may be that the instruments in use do not assess the students' learning approaches in a valid way. Moreover Boekaerts, Otten, and Simons (1997; cited by Rozendaal, Minnaert & Boekaerts, 2001) show that some research suggest that most students are not aware of their learning style and therefore students, particularly those under the age of thirteen, seem to have difficulty grasping the meaning of the rather general, abstractly formulated items on the learning style questionnaires.

For the sake of completeness there should be mentioned the “learning tests” sensu Guthke (e.g. Guthke, 1999; Guthke & Beckmann 2003), which are an alternative to the so called “status-tests” especially for the assessment of intelligence. The typical characteristics are the systematic integration of standardised feedbacks and prompts within reasoning tests (like e.g. ACIL; Beckmann & Guthke, 1990) analysing the “intellectual ability to learn” (Guthke & Wiedl, 1996) or “cognitive modifiability” (sensu Feuerstein, Rand & Hoffman, 1979). The concept of “dynamic testing” was extended beyond the scope of intelligence testing. It is now also an applied method for the "psychodiagnosis of intra-individual variability" of non-intellectual personality characteristics (Guthke & Wiedl, 1996). Anyway, these kinds of test procedures like the “learning tests” sensu Guthke bring incremental validity in particular for testees that are underprivileged or have an irregular history of previous learning (Guthke & Beckmann, 2003), but are not absolutely appropriate for personnel selection.

In the sense of common framework also inventories analysing the *Five Factor Model personality traits* (like e.g. the NEO-PI-R by Costa and McCrae, 1992; the HPI by Hogan & Hogan, 1992 and the Big 5 Plus One (*B5PO* by Holocher-Ertl, Kubinger, & Menghin, 2003) are used for prediction of academic and work performance. Most meta-analyses have suggested that two of the big five – *conscientiousness* and *emotional stability* – are positively correlated with job performance in virtually all jobs (cf. Barrick & Mount, 1991; Salgado 1997; Tett, Jackson & Rothstein, 1991). Nevertheless in context of personnel selection both the use of questionnaires for the analysis of learning potential and approaches and personality inventories are suboptimal, because of the problems, that answers can be faked in a socially expected way, answers might be biased because of response set or might lead to other answer distortions (cf. Dilchert, Ones, Viswesvaran, & Deller, 2006; Kubinger, 2002; Viswesvaran & Ones, 1999). The Q-data are not only susceptible to voluntary (faking, social desirability) but moreover also to involuntary biases (tendency to acquiescence or the inaccuracy of language) and therefore not always adequate for an assessment (Santacreu, Rubio & Hernández, 2006).

1.2 LAsO – a new experiment-based behavioral task

As it seems difficult to find economical and helpful instruments for a valid analysis of learning potential and approaches as predictors for school and job performance without the use of introspection, there is a need of innovative operationalisation. This might be realised within an *experiment-based behavioral task (EBT)*, which is according to Kubinger (2006) a more concise denomination of *objective personality tests* sensu R.B. Cattell: An EBT analyses, like an objective personality test (Cattell & Warburton, 1967), individual working styles due to the observation of a person’s behavior within a specific achievement-task. The registry of the detailed way the problem gets solved and handled is assumed by the computer. This approach has been resumed recently by Ortner, Proyer and Kubinger (2006). In order to assess *learning potential and approaches* Fill Giordano and Litzenberger (2005) designed the new EBT called LAsO (Learning, Applying – systematically Organizing) administered by the computer. The achievement-task for the testee is to reach a learning target, which consists of different contents to learn. These contents are invented numbers, words, names and symbols and are new to every testee. However, the contents seem to be fair for both gender and testees with different experience with computers (Fill Giordano, Litzenberger & Kubinger, 2003).

As Creß (2006) explained that there is no agreement about which behavior pattern or criteria could be included as characteristics in a possible learning classification, because there are many different definitions of students' ability to select, combine, and coordinate cognitive strategies in an effective way, which are partly similar in content, for the design of the EBT LAsO and the computation of indicators and scores, Fill Giordano and Litzenberger (2005) started from a rather pragmatic point. Moreover the design leans partly on an earlier test concept called LAMBDA (Maryschka, 2001). Due to the fact that several models give an explanation for the complexity of the learning process itself, which demand a broad spectrum of abilities, capacities, strategies and self related knowledge (cf. Boekaerts, 1997; Friedrich & Mandl, 1997; Garcia & Pintrich, 1994; Schunk & Zimmerman, 1994), accordingly to the *multifunctional tests* (Wagner-Menghin, 2006) there need to be integrated two (or more) aspects: Interesting and observable within the EBT LAsO is on one hand the output itself, that is the *learning achievement*, but on the other hand the shown *time effort* and moreover the *preferred approach* and *tempo during learning* shown by the testee while trying to reach the given target. Since one way to obtain detailed information about the reasons for success in learning is to introduce a design with more measurement occasions (Schmitz, 2006), the design of the EBT LAsO is a standardised learning process with several consecutive observations, which should give the opportunity to analyse also the learning progresses and the time management. However, this leads to a procedural point of view allowing a detailed observation of behavior in several moments, in so called different phases.

1.2.1 A micro cyclical learning process

Corresponding to the model of Schmitz and Wiese (1999), who describe learning as a process with *preactional, actional* and *postactional phases* (see Schmitz, 2001) and accordingly to several models summarized and described by Puustinen and Pulkkinen (2001) the EBT LAsO is also organised in three phases: a *preparatory phase* giving an introduction, a *performance phase*, where the testee works on the learning material and an *appraisal phase*, where the testee gets examined. In the (1) *instruction phase* the testee reads the instructions, looks at some given examples, and tries the learning-testing procedure. In this *preparatory phase* he has time to prepare himself for the following objectives: understanding the goal, defining the task, selecting strategies and planning the time and effort to implement strategies. In the (2) *learning phase,* which is equivalent to the *performance phase* the testee starts to learn the given contents in a self-regulated way: applies strategies, monitors progress toward goals, and adapts strategies to fit the circumstance revealed by the monitoring process. In the (3) *testing phase*, which is equivalent to *appraisal phase* the testee is able to test himself, being presented with some learned material containing different errors, which he needs to recognise and revises by selecting the right answer out of 16 given distractors. Leaning on the social-cognitive model of Zimmerman (1989, 2000), which explains the reciprocal cooperation of person, behavior plus environment and describes learning as cyclical, the shape of the EBT LAsO is equal a cyclical procedure (see figure 1).

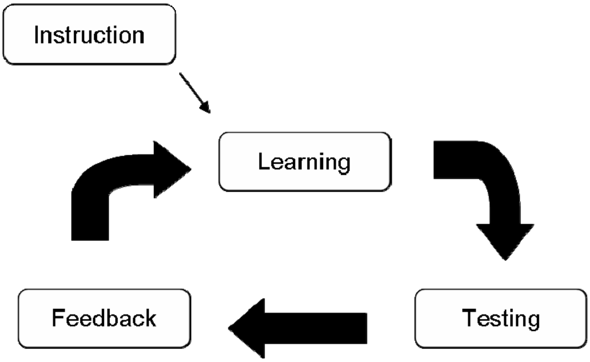

Figure 1:
The basic shape of the EBT LAsO – the cyclical phases
(introduction, learning, testing and feedback)

Within this cyclical organisation the testee is able to act differently and might adapt his learning approach after some feedback (well-done or not). The feedback from prior performance is used to make adjustments during current efforts (Zimmerman, 2000). This cyclical process of phases following one another is ongoing until the testee reaches the target of consecutively solving four *testing phases* correctly.

1.2.2 Freedom in action for an individual approach and valid indicators

The design and operationalisation leans partly on an earlier test concept called LAMBDA (described in Ortner, 2002; Kubinger, 2006), which shows also learning and testing phases. However, while the learning phase in LAMBDA is equivalent to a fixed organigram (Maryschka, 2001), the EBT LAsO contains a web-site and gives the testee more freedom in action. Therefore LAsO offers as results a more detailed analysis. Allowing an individual approach within the new EBT LAsO, learners are able to influence this diverse action by deciding if, what, when, how and what for they are learning (Weinert, 1982). Beside the given target the EBT LAsO gives the opportunity to "move freely" within the standardised process. Therefore the testee is able to decide on his own when to learn and when to go on into the *testing phase*, where he needs to decide by himself what to do. In order to give the opportunity for a detailed observation of the learning behavior for the measurement of *learning approaches*, the *learning phase* (performance phase) itself is built as a web-site, which shows the learning material on different sites in a specific order. There are some single sites, which give an *overview* while others show the *learning bits* as detailed material for memorization due to the *testing phase*. The single contents to learn are not shown together on any web-site, but need to be combined in the testee's mind. The learning material itself is a mixture of verbal, numerical and figural information, containing implicit structures, which are not obvious but, might be recognized by the testee. This gives the testee the opportunity to use elaboration and organizational strategies. This design enables a detailed learning way to be registered and gives the opportunity to recognize patterns (preferences of organization of learning material and the shown learning way), leading to an analysis of learning approaches.

2. Research questions

The assessment of *learning achievement, time effort, learning approaches* and *tempo during learning* on a behavioral level needs to be analysed due to (1) *reliability* and (2) *incremental validity* and therefore we analyse the following research questions:

1) Are the single observations of behavior in several moments over the learning process (meaning within different *learning* and *testing phases*) reliable?
2) Are the LAsO-scores *learning achievement, time effort, learning approaches* and *tempo during learning* significant predictors for *high*- and *low-potentials* incrementing validity?

Following Gamsjäger and Sauer (1996), who report, that school performance is explained for 33.6% by the estimation of the students behavior through the teacher and as the self-estimation of *conscientiousness* analysed within a questionnaire seems to be a valid predictor for academic performance (Busato, Prins, Elshout & Hamaker, 2000) and work performance (Barrick, Mount & Judge, 2001), we analyse the incremental validity within a two block binary logistic regression as follows: In the first block we integrate the estimation of the apprentices *behavior* through the formation team and the self-estimation of *conscientiousness* and expect even more explained variance after adding in a second block the LAsO-scores *learning achievement, time effort, learning approaches and tempo during learning.*

According to Wittmann (1988) the external criteria-validity is only high, if the predictor and the criteria are symmetric regarding their generality. Therefore we expect that the external criteria *performance in knowledge* regarding the written examination in four subjects and the *performance in practice* regarding the practical-technical skills correlate with different LAsO-scores. As a preceding study by Artelt (1999), where micro analytic action research was used, showed that the *deep processing level approaches* do have an influence on the learning achievement and the *performance in knowledge* should be equal the ability to learn specific material during the EBT LAsO, we expect that variance gets explained by the LAsO-scores *learning achievement* and *learning approach – surface vs. deep processing level*. Whereas *performance in practice* describing the skills of metal-craftwork should correlate with their working style respectively the LAsO-score *tempo during learning*.

3. Method

3.1 Participants

A group of 322 apprentices, who entered a technical- or a commercial-practice vocational training at the Austrian National Railways (Österreichische Bundesbahn), participated in this study during their three month qualifying period. The sample consists of n_{males}=307, $n_{females}$=15 with a mean age of 15.8 years (*SD*=.49).

3.2 Procedure and material

All newcomer apprentices of the Austrian National Railways have to absolve a qualifying period of three months before getting a regular apprenticeship. During this period all apprentices performed the EBT LAsO and the self-estimation of conscientiousness within the B5PO (Holocher-Ertl et al., 2003) in small groups of 4 to 6 persons in a computer room in one of the 12 apprenticeship workshops voluntarily. They all were asked to work properly during the assessment, because the results were used to check the individual creditableness, the motivation and the working attitude during the qualifying period. As further motivation the single apprentices had afterwards the chance to get information about their individual learning strategies.

As external criteria we used the two final qualifying examinations after the qualifying period**:** one examination describes their *performance in knowledge* and the other their *performance in practice.* Moreover their *behavior* shown in the qualifying period got valuated by the formation team.

3.2.1 External criteria and the extreme-groups low- and high-potentials

An apprentice is only allowed to go on with a regular apprenticeship, if the examination performances are positive, otherwise the apprenticeship gets cancelled. Both *examination performances* get valuated with a score between 0 and 100, which must be over 55 for being positive. For discrimination between *successful* and *non-successful* apprentices we formed for each external criterion two extreme-groups: (1) the *low-potentials*, who showed a too low score for getting a regular apprenticeship and (2) the *high-potentials*, who reached a very high score at the examinations either in *performance in knowledge* (over 89.9 points) or *in practice* (over 86 points).

Therefore we formed two groups of *low-* and *high-potentials* for each external criteria:

A) *Performance in knowledge.* After the apprentice gets examined on the basis of written tests in four different subjects (German language, technical calculating, technical drawing and special subject education), the single grade is summarised in a score describing the "*performance in knowledge*", (M=74.3, SD=13.6). There are 26 *low-potentials* showing an insufficiently low *performance in knowledge*.

B) *Performance in practice.* An analysis of the practical skills occurs while the apprentice must manufacture within a specific time period a specimen and gets valuated by the teachers due to different performing criteria, which is equivalent to the score "*performance in practice*" (M=71.6, SD=11.7). There are 29 *low-potentials* showing an insufficiently low *performance in practice*.

Moreover the two external criteria *performance in knowledge* and *performance in practice* are positively correlated (n=322) r=.253, what means that apprentices, who did well in the written tests were not necessarily that successful in manufacturing a specimen within a specific time period.

Furthermore during the qualifying period the behavior of the apprentice got valuated through the formation team, who used over a certain time period a systematic scoring system called "*behavior*" (1 for *very good* (71.7%), 2 for *good* (26,1%) and 3 for *misconduct behavior* (2.2%) and for each score there is a short description of behavior.

3.2.2 Self-reported conscientiousness using the B5PO

As employees with a high score on *conscientiousness* should obtain higher work performance (Barrick, et al., 2001) for the selection of *high-* and *low-potentials* we used for time-economical reasons the short scale *Big 5 Plus One* personality inventory (B5PO, Holocher-Ertl et al., 2003) for analysing *conscientiousness.* The scale *conscientiousness* counts 11 items, which consist in bipolar pairs of adjectives. The B5PO is a computerised inventory, which allows a self-estimation by the testee on a bipolar analogue-scale. The items are well scaled because of their Rasch-homogeneity. The construction validity is given for the big five model (Holocher-Ertl et al., 2003) as well.

3.2.3 Description of the experiment-based behavioral task LAsO

To achieve a realistic standardized learning process, the multifunctional EBT called Learning, Applying – systematically Organizing (LAsO, Fill Giordano & Litzenberger, 2008) is administered through a realistic story board, where the testee assumes the role of a new trainee for a fictional company. The individual is asked to reach a certain learning target, by memorizing different details about their new colleagues in the *learning phase* and then regurgitate this information in the *testing phase*. The information about these new colleagues is divided on 26 single web-sites showing different structures of the material for the analysis of the favourite *learning approaches*. The testee is asked to learn the given contents in the *learning phase* as long as he wants to and whenever he feels prepared he can change into the *testing phase*. After every *testing phase* the testee might get some positive feedback about the correctness and after that he gets the opportunity to rehearse the learning material to improve for a new attempt at the *testing phase*.

Besides the given target of solving four consecutive *testing phases* correctly, the testee has the opportunity to work in a self-regulated way highly influencing this diverse action by deciding if, what, when and what for he is learning (Weinert, 1982) by: (1) managing his way of proceeding, (2) deciding about the required time effort, (3) respecting his individual learning style (e.g. either surface or deep-processing level), (4) repeating contents as often as he wants to (metacognitional skills), (5) choosing his individual learning way and (6) working on his own speed. Moreover, these decisions need to be taken while learning after every single *testing phase*. This gives the opportunity to observe behavior – through the computer records – after a single success or failure, which leads to further predictions about interactions.

3.2.4 The LAsO-scores

The used LAsO-scores are described as follows:

1) The *learning achievement* is equivalent to the correct solved items divided by the amount of taken items stating the performance of all assigned *testing phases*. The higher the score, the better is the *learning achievement* (M=.601; SD=.146).
2) The *time effort* is the sum of time spent for learning independently from the success described in seconds (M=1388; SD=321).
3) The *tempo during learning* is the average time described in seconds divided through the amount of taken learning phases. It shows how much time the testee spends for a single learning phase in average. The longer the time (in seconds) the more the testee worked reflexively and usually also more precisely (M=64; SD=44).
4) The *learning approach – surface vs. deep processing level* leans on the model of Marton and Säljö (1984), who introduced the *surface or shallow-* and *deep-processing level* as *learning approaches*. The more a testee looks in the main four *learning phases* in a detailed way at a great amount of learning web-sites, giving himself the opportunity of elaboration and organisation, the more he shows a *deep-processing approach*, which is typical of students who want to understand the material (M=81; SD=51).

Table 1 shows that as expected the *learning approach* correlates middle high (r=.551) with the *learning achievement*, but smaller and negative (r=-.156) with *time effort*. Similarly, the correlation between *time effort* and *learning achievement* (r= -.322) is also negative, which means that those, who show a deep level approach, do need less time for a better output. There is a small coherence between *tempo during learning* and the *learning approach*, which means, that those apprentices showing a deep level approach might work a little slower.

Table 1:
Correlations between the LAsO-scores (n= 322)

		time effort for learning	*learning tempo*	*learning approaches*
learning achievement	Pearson Correlation	**-.332**	.103	**.551**
	Sig. (2-tailed)	<.001	.064	<.001
time effort	Pearson Correlation		.012	**-.156**
	Sig. (2-tailed)		.827	.006
tempo during learning	Pearson Correlation			**.137**
	Sig. (2-tailed)			.016

4. Results

4.1 Reliability

For an analysis of reliability we applied the Spearman Brown split half reliability (*n*=322).

Conscientiousness. In the sense of internal consistency reliability is given because of the valid Rasch-model (Holocher-Ertl et al., 2003).

LAsO-scores. For the *learning achievement* we analysed the first four *testing phases*, in order that there are no repeated items and the split half reliability is satisfying with a ρ=.831. For the other scores we analyse on one hand the *single learning times* (*n*=274, ρ=.592) within the learning process and on the other the *amount of learned sites* (for the *deep-shallow-level-approach*) (*n*=274, ρ=.579) within 11 *learning phases* (more than 75% of the sample worked on these), excluding the first actional phase, where the testee might organize and work more, than in the following ones.

4.2 Incremental validity

4.2.1 Method

For a useful analysis of external validity the predictors should discriminate between (1) the so called *low-potentials*, who did not reach a positive score at the examination and a similar group in size (2) the so called *high-potentials*, who did perform very well. The analysis of incremental validity occurs separately for the *knowledge* and the *practical performance* through a binary logistic regression (with two blocks) after converting all variables to z scores and using the method Wald Forward Stepwise: In the first block we include the two predictors *behavior* and *conscientiousness* and in the second one the LAsO-scores expecting better results. For a detailed description, the significant LAsO-scores get analysed within an ANOVA.

4.2.2 The extreme-groups low- and high-potentials

As shown in table 2, out of the 322 only 11 apprentices reached an insufficient grade in both examinations, in total there were 44 *low-potentials,* of whom *n*=26 showed a low performance in *knowledge* and *n*=29 in *practice*. For the binary logistic regression analysis we

Table 2:
Crosstabulation for high- and low-potentials in performance in knowledge and in practice

		performance in practice			Total
		low-potential	no extreme	*high-potential*	
performance in knowledge	*low-potential*	11	13	2	26
	no extreme	18	224	24	266
	high-potential	0	21	9	30
Total		29	258	35	322

selected for every *low-potential* group a similar group in size of the best apprentices: For the *performance in knowledge* we chose *n*=30 (8.1%) apprentices as *high-potentials*, who reached a score over 89.9 out of 100 points and for the *performance in practice n*=35 (9.4%) apprentices, who reached a score over 86 out of 100 points.

Out of the 35 *high-potentials* 9 apprentices show high scores in both examinations. Two of the apprentices show a low *performance in knowledge* and a high in practice. In the pool of *high*- and *low-potentials* there are in total *n*=98 apprentices. However the single samples count regarding the *performance in knowledge* in total *n*=56 (of which *n*=26 (7.0%) *low*- and *n*=30 (8.1%) *high-potentials*) and regarding the *performance in practice* in total *n*=64 (*n*=29 (7.8%) *low*- and *n*=35 (9.4%) *high-potentials*).

4.2.3 Predicting performance in knowledge and in practice

Comparing the binary logistic regressions (with two blocks each, using the method Wald Forward Stepwise, see table 3) for both single external criteria *(A) performance in knowledge* and *(B) in practice* the results do show similarities: In both cases in the first block only the score *behavior* predicts the external criteria, while *conscientiousness* is not significant and for both regressions there is an increase of validity in the second block after adding the LAsO-scores.

Table 3:
Summary of the Regression with two blocks (binary logistic Regression) using the method Wald Forward Stepwise

	(A) performance in knowledge *n*=56			***(B) performance in practice*** *n*=64		
Variables entered	*B*	*SE*	*sig.*	*B*	*SE*	*sig.*
Block 1						
behavior	-1.430	.351	**<.001**	-1,531	.365	**<.001**
conscientiousness	--	--	.971	--	--	.319
Cox and Snell R-Square 1	**.329**			**.355**		
Block 2						
behavior	-1.748	.522	**.001**	-1,493	.394	**<.001**
conscientiousness	--	--	.971	--	--	.319
learning achievement	2.204	.684	**.001**	--	--	.425
learning approaches	--	--	.376	--	--	.631
time effort	--	--	.080	--	--	.949
tempo during learning	--	--	.405	1.047	.484	**.030**
Cox and Snell R-Square 2	**.523**			**.414**		
R-Square-Change	**.194**			**.059**		

Note. *B* = regression coefficient obtained for each predicting variable in the single block. All variables were converted to z scores prior to analysis.

The predictive validity increases (*R-Square-Change(A)*=.194) from *R-Square1(A)*=.329 to *R-Square2(A)*=.523. *R-Square1(A)*=.329 is due to the score *behavior*. In *block two (A)* the *R-Square(A)* increases to *R-Square2(A)*=.523 in consequence of adding the LAsO-score *learning achievement*. Further results (ANOVA) point out that the *high-potentials* do show a better learning output in both situations, yielding a main effect size of *ES*=1.4, (*F*=27.254, *df*=1, *p*<.001) in the LAsO-score *learning achievement*. We expected that not only the *learning achievement* predicts real life performance but also the LAsO-score *learning approaches*. Even though the ANOVA shows significant differences between the two groups in expected direction, where the *high-potentials* do show a deeper level approach with a main effect size of *ES*=.58, (*F*=4.726, *df*=1, *p*<.05), the score seems not to have enough power for discrimination within the regression between *low-* and *high-potentials* in real life. It might be a covariate (see table 1, *r*=.551).

However the LAsO-score *learning achievement* increases the incremental validity value for 19.4% in utility. Therefore regarding the *performance in knowledge* there results a correct classification of 83.9% for the *high-potentials* and of 84.6% for the *low-potentials* (see table 4).

The predictive validity for *(B) performance in practice* also increases *(R-Square-Change(B)*=.059) from *R-Square1(B)*=.355 to *R-Square2(B)*=.414. *R-Square1(B)*=.355 is also due to the score *behavior* (cf. table 3). In *block two (B)* the *R-Square* increases to *R-Square2(B)*=.414 in consequence of adding the LAsO-score *tempo during learning*. Further results (ANOVA) point out that the *high-potentials* show a slower *tempo during learning* and therefore work more precisely in both situations, yielding a main effect size of *ES*=.81, (*F*=10.473, *df*=1, *p*<.005). Thus, we can interpret the incremental validity value as at least a

Table 4:

Classification for low- and high potentials regarding (A) performance in knowledge

Observed		Predicted		
		(A) performance in knowledge		Percentage Correct
		low-potentials	*high-potentials*	
(A) performance in knowledge	*low-potentials*	22	4	84.6
	high-potentials	5	25	83.3
Overall Percentage				83.9

Table 5:

Classification for low- and high-potentials regarding (B) performance in practice

Observed		Predicted		
		(B) performance in practice		Percentage Correct
		low-potentials	*high-potentials*	
(B) performance in practice	*low-potentials*	20	9	69.0
	high-potentials	2	33	94.3
Overall Percentage				82.8

small increase of 5.9% in utility. Out of this, the classification of apprentices regarding their *performance in knowledge* results in 94.3% correct for the *high-potentials* and in 69.0% correct for the *low-potentials* (see table 5).

5. Discussion

Due to the reported problems with common used questionnaires for assessing learning approaches, there is a need of innovative appendage for appraisal of aptitude (Sarges & Scheffer, 2008). Therefore in this study the assessment of *learning achievement, time effort, learning approaches* and *tempo during learning* was analysed on a behavioral level with an experiment-based behavioral task called LAsO (Fill Giordano & Litzenberger, 2008). In this study the relevant LAsO-scores were analysed due to (1) *reliability* and (2) *incremental validity*.

At least for the *learning achievement* the split half reliability is satisfying with a ρ=.831, while for the other LAsO-scores *time effort, learning approaches* and *tempo during learning* the split half reliability is rather low and might be explained as follows: The showed *tempo* and *learning approach* in every single learning phase can't be reliable over the whole learning process, because a good time management and useful learning strategy means a disproportional effort and elaboration of the learning material in the single phases due to the need. For example, the *time effort* at the beginning of a learning process is much higher for planning and organising the learning material than in the following learning phases, where material gets only repeated. A good learner might use one single learning phase for a much deeper elaboration of the material, because of low success in the prior testing phase and therefore shows an unreliable learning approach. As these LAsO-scores cannot be reliable over the whole learning process, their reliability should be analysed by parallel-testing.

The concept of increment validity has been presented by different authors as a rather generic form of validity that describes the ability of a measure to predict a variable of interest beyond what is possible with other data (e.g. Dawes, 1999; Haynes & Lench, 2003). The approach of increment validity as validation of an instrument or score, which is described by Hunsley and Meyer (2003), is furthermore useful to justify how a new instrument or score provides information, which was formerly unavailable or less adequately obtained. The analysis of incremental validity occurred separately for the *performance in knowledge* and *in practice* through a binary logistic regression (with two blocks) using the method Wald Forward Stepwise: In the first block we included the two predictors *behavior* (estimation of the behavior during the qualifying period by the formation team) and *conscientiousness* (a scale of the short scale *B5PO*, Holocher-Ertl et al., 2003). In the second block we added the LAsO-scores expecting better results. After that the significant LAsO-scores were analysed within an ANOVA.

The predictive validity for the groups *low-* and *high-potentials* (out of n=322 apprentices) is for both external criteria (*(A) performance in knowledge* and *(B) performance in practice*) quite satisfying due to the score *behavior*. However *conscientiousness* is not significant in any regression analysis. The score *behavior* leads to an *R-Square1(A)*=.329 for *(A) performance in knowledge* and an *R-Square1(B)*=.355 for *(B) performance in practice*. These results of an average effect of the score *behavior* accordingly to Cohen´s (1988, 1992) benchmark of r=.30, seems equivalent to the study of Gamsjäger & Sauer (1996), who report, that school performance is explained by 33.6% by the estimation of the students behavior through the teacher. Unlike expected in these studies *conscientiousness* did not discriminate between the groups. This might be due to the problems with questionnaires, which can be faked in a socially expected way (Dilchert, et al., 2006; Kubinger, 2002; Viswesvaran & Ones, 1999) and therefore lead especially in context of personnel selection to unsatisfying results. As the apprentices were told, that the results were also used to check the individual creditableness, the motivation and the working attitude during the qualifying period, they might have faked good the personality inventory B5PO. Another reason for these results might be the short scale-questionnaire B5PO itself, which items consist in bipolar pairs of adjectives and therefore might not yield the same predictive power as a classical questionnaire (like e.g. the NEO-PI-R by Costa and McCrae, 1992).

In both studies the adding of the LAsO-scores *learning achievement, time effort, learning approaches* and *tempo during learning* to the scores *behavior* and *conscientiousness* yielded in both blocks to a higher combined *R-Square2* (*R-Square2(A)*=.523 and *R-Square2(B)* =.414). Therefore single LAsO-scores seem to be largely independent from the first variable and do increase validity. As we expected, different LAsO-scores predict different external criteria and the performance in real life *(performance in knowledge)* is predicted by the LAsO-score *learning achievement*. The high-potentials of this group do not only show a better output in a real life situation (examination) but also a better performance in the EBT LAsO. Therefore validity increases for 19.4% over what is available from using only the behavior estimation through the formation team. In this case it is the *learning achievement* predicting achievement in knowledge in real life.

As a preceding study by Artelt (1999), where micro analytic action research was used, showed that the deep processing approaches do have an influence on the learning achievement, we expected also the LAsO-score *learning approaches* to predict the *performance in knowledge*. As in this study only *learning achievement* itself predicts real life performance, the *learning approaches* shown during the EBT LAsO might be a covariate (see table 1; r=.551) but not having any power for discrimination within the regression between *low-* and *high-potentials* in real life, even though the ANOVA shows significant differences between the two groups in expected direction, where the *high-potentials* do show a deeper level approach with a main effect size of ES=.58, (F=4.726, df=1, p<.05). This leads to the conclusion that the LAsO-score *learning approaches* should be composed in a different way.

But the same LAsO-score *learning achievement* does not predict *performance in practice*. Last is predicted by the *tempo during learning* increasing validity of 5.9%. This means that the working attitude has an influence not only on a real life situation (manufacturing within a specific time period a specimen) but also during work in the EBT LAsO. The results derive from the different tempo during working and learning of the two groups: While the *low-potentials* work in both situations faster and less precise, the *high-potentials* take their time and show a better output. Even though the results show that the two different external criteria correlate with different indicators of the EBT LAsO incrementing validity in a comprehensible way, LAsO should be improved in future as follows: Due to the fact that the LAsO-score *learning approaches* shows a rather high correlation with the *learning achievement*, it should be revised. Instead of the amount of learning web-sites (in the main for learning phases), the LAsO-score *learning approaches* could be the analysis of the log-book, which registers detailed information about the individual way of looking at the learning material. This gives the opportunity to find out the individual learning approach regarding the single web-sites, which either show an *overview* or detailed *learning bits.*

Similar to the research of Spörer and Brunstein (2006) the conclusion of this paper is to use multi-method approaches. Comparative to a report of Veenman and Hoult-Wolters (2002; cited by Veeman, 2005), which described that in 21 studies, where there were used learning questionnaires with over 7000 participants, the average of explained variance of the scores for performance in real life was only 3%, both studies are more than satisfying. Thus the analysis of behavior during learning seems to predict real performance better than self-reported descriptions and estimations of it, we recommend in context of appraisal of aptitude and for the identification of *high-* and *low-potentials* to use also experiment-based behavioral tasks and behavioral analyses (Jamison-Noel, & Winne, 2003). Especially for personnel selection but also in research we recommend to use not only questionnaires or not only to collect data about the estimation of behavior by the formation team, but to integrate different methods. As long as there is evidence of validity also self-reported data should be integrated in decisions in personnel selection (Marcus, 2006). However, for a valid recognition of qualified manpower there should be used a multi-method approach integrating also experiment-based behavioral tasks like LAsO (e.g. Frebort, Kubinger & Holocher-Ertl, 2006). It seems comprehensible that the behavior in a standardised situation is similar to the shown behavior in any real life situation. Therefore the analysis of *learning achievement* and *tempo during learning* within LAsO might give a new opportunity for a better prediction of *low-* and *high-potentials* in the specific context of personnel selection.

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