

***Structural equation modelling of factors affecting success
in student's performance in ODL-Programs:
Extending Quality Management concepts***

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Abstract

Learning using e-learning methods is often said to be cheaper, more efficient and flexible (Aufenanger, 1999; Kerres, 2000). So what does actually mean the term 'flexibility' in the context of learning and e-learning? How can the relationship between flexibility in learning and learning performance be described? According to Schiefele (2005) we have developed a model which allows first of all postulating a relationship between learning strategies, flexibility of learning and other variables. In a first step we created an instrument in form of a questionnaire to bring up empiric evidence of which factors flexibility of learning environments consists. The results showed three categories flexibility of time, flexibility of teacher contact and flexibility regarding the content. Together with other variables of the postulated model it is possible to create data which allows the enhancement of the quality management of learning environments within four scopes: (1) by giving the students feedback and advice to initiate reflexion to their learning strategies, (2) by sensitize tutors towards the learning patterns used by the students, (3) by using the results for the training of tutors and advice for learners and (4) by also using them for adaptations of the learning environment.

1. Learning strategies and learning performance

Models of learning strategies open the opportunity to formulate statements about the relationships between learning patterns and success in learning performance. On a general level, a distinction of three groups of learning strategies is often used: cognitive, meta-cognitive and resource based learning strategies (Wild, 2000). Due to the greater amount of control and more flexibility of learning resources in time and space (Bergamin & Brunner-Amacker, 2007) we propose for university ODL Scenarios that learning strategies which concern meta-cognitive control and the "management" of internal resources lead to higher correlations to successful learning performance compared to cognitive or resource based learning strategies.

In our model which serves to predict learning performance we consider that besides the learning strategies and perceived flexibility, also other variables have to be taken in account. Figure 1 shows the model. In contrary to the registration of specific current learning strategies the habitual learning strategies are mainly recorded by questionnaires (Metzger et al., 1995; Wild & Schiefele, 1994). Experimental studies often report that adequate correlations are not found or are showing relative low coherence (Artelt, 1999; Schiefele, 2005). This does not mean that habitual learning strategies are not relevant to predict learning performance but that the findings of experimental studies could not directly be transferred to real learning settings

(Schiefele, 2005). We assume like others that the reasons for the low coherence could be allocated on the one hand in the validity and/or reliability of measuring learning performance but also on the other hand to in the research setting not considering variables which affect the relationship between learning strategies and learning performance (Boerner, Seeber, Keller & Beinborn, 2005). For instance Artelt (1999) and Schiefele (2005) point out that the use of research designs which are close to the observation of behaviour lead to higher coherence. In our view less the coherence between learning strategies and learning performance should be put into question than the operationalisation of these two concepts (Tiaden, 2006).

Due to the lack of empiric research the effect of the perception of flexibility of the learning environment to the learning performance is not yet clarified even unknown. Therefore we propose explorative studies based on the method of structural equation modelling (SEM) to bring up some clarification. But before doing this we have to develop an instrument to record flexibility of learning processes. Therefore the main part of this article refers to the retrieval of perceived flexibility as a variable that affects learning performance (see chapter 3). Other possible determining factors will be discussed in chapter 4.

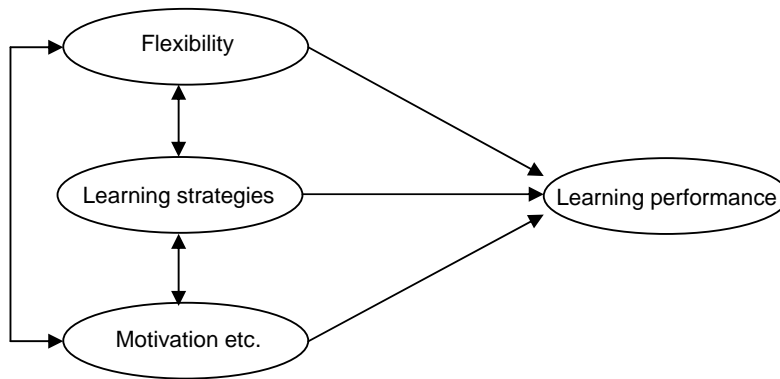


Figure 1: Model to predict learning performance

2. Methodological Approach

The development of the instrument resp. questionnaire to record the perceived flexibility is based on a research design of factor analysis. Based on a principal component analysis (PCA) with a varimax rotation we conducted an explorative search to find a structure of factors, which allows an interpretation regarding theoretical assumptions. The internal consistency of the scales we have found, were assessed by an item analysis and indicated by Cronbach's Alpha. In the next steps which cannot be referred yet, there should follow an examination of the impact of the single components to each other based on structural equation modelling (SEM) as already mentioned above. The method of SEM compared to method of multiple regression allows through different forms of trials to vary causal structures. Thus there could be assigned some methodological advantages to use of SEM in the present situation. Due to already referred findings on the coherence of learning strategies and learning performance there should also taken in account that some variables assumed in our model could also not stand in a direct interrelationship to the learning performance but can interact as an mediator or moderator.

3. Flexibility of the learning environment as a factor

There are several authors postulating flexibility in time and space as advantages of e-learning compared to environments based on traditional learning methods (Seufert & Mayr, 2002). Although Schulmeister (2006) is not using the term of flexibility he mentions some qualities of e-learning which are seen by others as factors of flexibility by postulating that is possible to overcome four barriers by using e-learning: time, space, analogue to digital and norms (esp. the depersonalisation of mass education in higher education).

a. Record of the perceived flexibility of learning environments

In the literature one can find numerous and different concepts of flexibility of learning (Van den Brande, 1994). Garrick und Jakupec point out: "Flexible learning is a complex concept and is difficult to define. Neither individuals nor organisations have yet been able to define this term from any one specific vantage point" (p. 3). For instance on the one hand Collis, Vingerhoets & Moonen (1997) list 19 dimensions of flexibility grouped into five categories on the other hand Van den Brande (1994) postulates only three categories without dimensions. This simple comparison shows already the diversity of the flexibility concepts. We will not go deeper into the discussion of differences but point out our approach. In our perspective dimensions are several facets of flexibility that can be combined to categories regarding theoretical assumptions. One can say that according to this conception categories of flexibility are cluster of the various dimensions. In our own theoretical research we have found 22 dimensions which can be clustered to seven Categories. Table 1 gives an overview of the different elements:

Table 1: categories and dimensions of the flexibility

categories	dimensions
time	<ul style="list-style-type: none"> - time of learning - duration of learning - teaching time - pace of learning
space	<ul style="list-style-type: none"> - delocalisation
methods	<ul style="list-style-type: none"> - learning place - learning material - language
learning styles	<ul style="list-style-type: none"> - individual work vs. group work - on campus study, online-study, self-study - learning strategies
content	<ul style="list-style-type: none"> - choice of topics - orientation of topics (theoretical, practical) - focus of topics
organisation & infrastructure	<ul style="list-style-type: none"> - combination of study, work, family - communication between student and teacher - information and communication technology - technical infrastructure - logistics of learning material
requirements	<ul style="list-style-type: none"> - entry requirements - forms of examination - time of examination

We define flexibility in time as possibility of the learner to decide when he learns (Seufert & Mayr, 2002; Van den Brande, 1994), to decide about the duration of learning (Collis, Vingerhoets & Moonen, 1997; Van den

Brande, 1994), if there are (nearly) no fixed teaching times (Walker & Harrington, 2005) and if choice of learning pace is possible (Collis, Vingerhoets & Moonen, 1997; Ling et al., 2001). With the term flexibility of space there should be expressed that learning is independent of local conditions (Kerres, 2001; Ling et al., 2001). Into the category of methods we include aspects as follows: places of mandatory meetings (Ling et al., 2001), available learning resources (Collis, Vingerhoets & Moonen, 1997), as well as the language of teaching and learning (Collis, Vingerhoets & Moonen, 1997). The category learning styles refers to possibilities of cooperation in the learning process (Collis, Vingerhoets & Moonen, 1997; Ling et al., 2001) and to specifications of how learning is running (Ling et al., 2001; Van den Brande, 1994). The category content deals on the one hand with the focus of the topics (Collis, Vingerhoets & Moonen, 1997; Ling et al., 2001; Van den Brande, 1994) and on the other hand with the differences between theoretical and practical learning and teaching approaches (Collis, Vingerhoets & Moonen, 1997). The category organisation & infrastructure comprehends the use of information- & communication technology (Collis, Vingerhoets & Moonen, 1997), the combination of study, work and family (Arbaugh, 2000), the communication between learner and teacher (Hart, 2000), the technological infrastructure as well as the logistics of learning material (Collis, Vingerhoets & Moonen, 1997). In the context of flexible learning one often finds in the literature statements to flexible entry requirements (Collis, Vingerhoets & Moonen, 1997; Hart, 2000) as well as to flexibility of time and form of examination (Hart, 2000; Ling et al., 2001; Collis, Vingerhoets & Moonen, 1997).

In his study Arbaugh (2000) used eight items to record the perceived flexibility of the learning processes of students. In his evaluation based on the method of factor analysis he found two factors: course flexibility and program flexibility. Thus we decided to develop a new instrument to record the flexibility of learning environments.

b. Sample

Based on the seven categories we generated 42 items. This item pool was evaluated by 10 collaborators of our Institute allow to upgrade comprehensibility of the single items. In December 2008 the questionnaire was filled out by 309 students which were enrolled in the first or third semester of the Bsc. in Psychology of the University of Berne. The students had time to fill out the questionnaire during a lecture. The sample consisted of 253 (82%) female and 56 (18%) male students. 282 students declared their age which varied between 18 and 47 years with an average of 22 years ($SD = 4.27$).

c. Evaluation and Results

In the first step we established an analysis of factors (principal component analysis with varimax rotation). With this procedure there were found 14 factors characterised by an eigenvalue higher than 1 and an explained variance 62%. The further evaluation with a scree plot of the eigenvalue led us to test also analysis with three and four fixed factors. The three factors solution opened a better resp. more coherent theoretical interpretation of the results and led us to prefer this variant. In the next step of evaluation all items with a load of factor less than 0.4 and which couldn't be allocated to one of the three factors on a theoretical level had been removed. Out of this procedure emerged a pool of 17 items which could be reduced to 13 items by conducting again two analysis of factors (PCA with varimax rotation) and the same rules of elimination of items. It even appeared also a distinct structure because items loading higher than 0.4

did do this only to one factor. With this definitive structure of the three factors we achieved an eigenvalue distribution of 2.69, 1.91 und 1.80 and an explained variance of 49%. These results together with the theoretical assumptions led us to name the three factors: flexibility of time, flexibility of contact with the teacher and flexibility regarding the content. Table 2 shows an overview of the three factors and the dedicated items. As last step we derived an item analysis of the scales of the three factors resp. categories. The first scale 'flexibility of time' consists of six items and a Cronbach's Alpha .74, the second scale 'flexibility of contact with the teacher' of three items with a Cronbach's Alpha of .70. The third scale 'flexibility regarding the content' which consists of four items with a Cronbach's Alpha of .57 can be denominated as a part of our initially postulated category organisation & infrastructure.

Table 2: Categories and items of the questionnaire (translated from german origin)

flexibility of time	flexibility of teacher contact	flexibility regarding the content
I can arrange the learning time myself	I can contact the teacher at any time	I have a stake in the focus of the topics of class
The learning pace is determined*	There are different possibilities available to contact the teacher	I can prioritise topics in my learning
I can decide, when I like to learn	Teacher are rarely at disposition to answer questions*	I can choose between the different learning forms: on campus study, online-study, self-study
I can define my learning pace myself		I can learn topics of special interest
I can decide how long the learning time is taking		
I can repeat the learning matters frequently		
$\alpha = .74$	$\alpha = .70$	$\alpha = .57$

* the items had been reversed in polarity for the evaluation

d. Discussion

As already mentioned the concepts of flexibility of learning are used at the moment in a very inconsistent manner (Van den Brande, 1994). We and others for instance Garrick and Jakupec (2000) are persuaded that there are at the moment no satisfying conceptions. In our study we tried to construct a concept which indicates enough different dimensions of flexible learning as well as allowing measuring them. Although it was not possible to confirm empirically all seven categories postulated on a theoretical level the two scales 'flexibility of time' and 'flexibility of teacher contact' showed a well and the scale 'flexibility regarding the content' a reasonable internal consistency. At this point we can't still not definitively clarify why the other categories couldn't be empirically confirmed. Possible reason could lie in a lack of relevance of some categories for the concept of flexible learning, in a deficient reproduction of factors through some items in the questionnaire or the extraction based on a factor analysis did not fit some group specificities of the sample.

The in the literature mostly mentioned category 'flexibility of time' (Collis, Vingerhoets & Moonen, 1997; Seufert & Mayr, 2002; Van den Brande, 1994; Walker & Harrington, 2005, Ling et al., 2001) was also

reproduced in this study. It was even possible to make it measurable with seven items. Only indirectly mentioned in the literature is the second encountered category 'flexibility of teacher contact'. Building a proper category and measuring it with five items we can appraise as a new findings of the study. For the third category 'flexibility regarding the content' considerations of some authors (Collis, Vingerhoets & Moonen, 1997; Ling et al., 2001; Van den Brande, 1994) existed already.

In some way we were surprised that in our study the factor 'flexibility in space' in the meaning of a delocalisation of learning was not reproduced. This factor is very often mentioned as an advantage of using e-learning methods ore ODL (Kerres, 2001, 2001; Ling et al., 2001; Seufert & Mayr, 2002). At the moment we assume, considering some unexplained questions mentioned above, that the impact of flexibility in space is sometimes overestimated because it is in the nature of learning respectively thinking and cognition to be independent of locations.

In a next step it will be important to analyse possible specificities of groups since we cannot exclude at this point finding another structure of factors in specific groups. For instance we can imagine that for a sample of ODL-Students there could be found some different results. Even when we will find again the same three factors it's necessary to analyse if there is a considerable difference between the samples. Last but not least we like to point out that the intention of the study was not the explanation of the total variance of flexibility of learning but to find constituent categories of flexibility in learning. This shows also the result 42% of explained variance. This means the results of this study can't and should not be interpreted in another way.

4. Empiric analysis of other affecting factors of learning performance

The above introduced model takes in account learning strategies, flexibility of the learning environment and other variables to predict learning performance. It is absolutely evident that there are other important factors which influence the learning performance. We will only mention some of them which are in relation to learning strategies like motivation, planning of time, concentration, exam nerves, identification of essentials, concentration, information processing, exam strategies and self control. Furthermore there is also to mention some other important and independent variables as previous knowledge, work, family situation and age. Taking in account of the huge variety of these different factors of affecting learning performance we will in the next studies analyse beside group's specificities also the above mentioned factors which are in relation to learning strategies.

5. Options to enhance quality management of teaching and learning

If there is for instance an e-learning offer planned resp. arranged it is necessary to provide specification of the quality of the offer (Tergan, 2004). Besides of the character of the learning settings the interaction with learners is a function of quality of learning (Clark & Sugrue, 1990). This means the learner and the learner perspective plays a much more important role as assumed a long time (Appli, 2005). This requires a new comprehension of quality in learning (Tergan & Schenkel, 2004). In this perspective it's crucial for the quality of learning environments that the learners experience elements of learning services as helpful (Ehlers, 2004). This means a systematic gaze to quality is profitable because quality of learning offers emerge with the learner and not per se. Hence learning environments has to be adapted continuously to learning stiles,

learning forms and aptitudes of the learners. We see four scopes of the results of our study to enhance quality management from the learner perspective: (1) by giving the students feedback and advice to initiate reflexion to their learning strategies, (2) by sensitize tutors towards the learning patterns used by the students, (3) by using the results for the training of tutors and advice for learners and (4) by also using them for adaptations of the learning environment.

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