Predicting the use of Blackboard and predicting the use of a Personal Digital Analyser with the Technology Acceptance Model
A comparative and cross-validation research among Dutch pupils aged 12-18

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This paper reports on a comparative and cross-validation research among Dutch pupils aged 12 – 18. Investigated are one sample for the use of Blackboard and another to investigate the use of a Personal Digital Analyser (PDA) with the Technology Acceptance Model (TAM). The Blackboard research replicates an American investigation on the same subject matter but involves a different target group. The most relevant outcome of the data analysis based on the questionnaire implies that the use of a PDA is much more attractive for pupils than the use of Blackboard. The results of the study clearly point out the important role of enjoyment, usefulness, and ease of use in the way that they positively influence the decision to use new technology and the subsequent actual use. There is a considerable degree of similarity as to the pattern and the results of the samples taken in relation to the effect of enjoyment on usefulness and on ease of use. The predicting value in both samples and in the American sample therefore shows a strong similarity.

1. Introduction

Children grow up differently with ICT than previous generations. Nowadays digital applications like MMS, SMS, mobile telephone, interactive games, MP3, digital cameras, web logs, etc. are frequently used. Children can chat with four or five other children at the same time. Problems can be solved by asking friends. Children make their own gaming rules. E-mailing is no longer regarded a popular medium and something rather to be used by granddads and grandmothers. According to Veen [1], a pupil's use of digital tools drops dramatically during school hours. At secondary school, children are confronted with electronic learning environments like Blackboard. 'An electronic learning environment (ELO) is a website in the form of an intranet which enables teachers and pupils to design education together. The electronic learning environment is the binding agent in competence based learning and using digital didactics' [2]. It can more or less be regarded as a learning environment managed by teachers. Although a Blackboard supported lesson will enhance the quality of education, teachers do not tend to see the benefits of a Blackboard supported lesson [3]. Critics like Kirschner [4] state that a teacher-controlled closed tool like Blackboard is a very restricted manifestation of an Open and Flexible Learning Environment. The use of separate digital tools like a Personal Digital Analyser (PDA) might well prove much more attractive for pupils. This paper reports on a research of one sample to investigate the use of Blackboard and another to investigate the use of a Personal Digital Analyser (PDA) with the Technology Acceptance Model (TAM). The Blackboard research replicates an American investigation on the same subject matter but involves a different target group. A questionnaire similar to the questionnaire from Yi's research' [7] serves as a (zero) measuring instrument. The questionnaire consists of 23 questions centred on the following items: Application specific self-efficacy; Enjoyment; Ease of use; Usefulness; Behavioural intention; Learning goal orientation.

1.1 Technology Acceptance Model (TAM)

Since the introduction by Davis [5], the Technology Acceptance Model (TAM) has been widely used for predicting the acceptance, adoption, and use of Information Systems. TAM has established a powerful model for explaining and predicting usage intentions and acceptance behaviour. Legrisa [6] concluded, after a literature study, that TAM can be regarded a useful model, but it has to be integrated into a broader one which would include variables related to both human and social change processes, and to the adoption of the innovation model. TAM does not explicitly include any social variables. TAM introduced two new constructs: perceived usefulness (the belief that using an application will increase one's performance) and perceived ease of use (the belief that one's use of an application will be free of effort). Yi [7] added enjoyment, learning goal orientation and application specific self-efficacy as external variables to the model.

1.2 Research questions and hypotheses

In an earlier investigation, Vrielink [3] concluded that the investigated secondary school for the Blackboard sample, had already achieved a lot regarding infrastructure and knowledge, but these changes still have to become embedded in practice. These results correspond to the results of Deinum [8]. Deinum [8] evaluated the introduction of Blackboard at thirty-five schools in the northern part of the Netherlands. Deinum [8] recommended the use of the discussion board for pupils to hand in their products. A project on a secondary school, with a Personal Digital Analyser to see what the effect is on learning if the pupils are mobile, is subject to compare with both Blackboard samples. The research questions are:

1. Is the Technology Acceptance Model (TAM) a valid model for pupils aged 12-18 for predicting the use of Blackboard and for predicting the use of a PDA?
2. Is the use of a PDA more attractive in education for children aged 12 -18 than the use of Blackboard?
3. What factors determine the use of Blackboard or the use of a PDA for pupils aged 12-18?
4. Is there a difference between pupils in lower classes (aged 12-15) and higher classes (aged 16-18)? (Only investigated for the Blackboard sample).
5. Is there a difference between males and females?
6. Is there a difference between American students in higher education and Dutch pupils at a secondary school in the way they respond to Blackboard?

Nowadays, in the Netherlands, pupils aged 12 – 18 are already familiarised with computers. Assuming that the use of computers in the USA and in the Netherlands do not differ very much, the expectation can be held that the same results will be generated as from Yi's research [7] among students aged 18-20 and Dutch pupils aged 12-18. Using a PDA comes closer to the traits of our new generation because pupils can influence their learning. More over, it is not the technology which makes learning challenging, but the way it is used and implemented. It's the highway, not the destination; the means rather than the end' [9]. Therefore the following four hypotheses were tested:

Hypothesis 1: The same internal and external factors as Yi's research [7], determine the behavioural intention to use Blackboard and to use a PDA.
Hypothesis 2: The use of a PDA is more attractive for pupils aged 12 - 18 than the use of Blackboard.
Hypothesis 3: These findings are independent of age and gender.
Hypothesis 4: The cross-validation of the research among American students in higher education aged 18-20 and Dutch pupils aged 12 - 18 shows the same results.

2. Research Methodology

A questionnaire similar to the questionnaire from Yi's research' [7] serves as a measuring instrument. At the top of the questionnaire, the pupil could fill in his/her name, age, class, gender. All the questionnaire items used an 11-point Likert-type scale where 0=completely disagree, 5=neither agree nor disagree, and 10=completely agree. Respondents Blackboard sample: Two hundred questionnaires were handed out at a secondary school in the north of the Netherlands (VMBO classes one and two and HAVO/VWO classes 1 t/m 6). One hundred and eighty pupils filled in the questionnaires of which nine of them in-

completely filled in the questionnaire. Eleven pupils indicated never to use Blackboard. Except for these twenty questionnaires, the other one hundred and sixty questionnaires, after analysis, provided answers to the research questions. Respondents PDA sample: Hundred and ten questionnaires were handed out at a secondary school in the east of the Netherlands (VMBO BB/KB classes one and two). One hundred and two questionnaires, after analysis, provided answers to the research questions.

3. Results and discussion

3.1. Respondents Blackboard sample and respondents PDA sample
Respondents Blackboard sample: The respondents' age ranges from 12 to 19. Most of the pupils are 14 years old (39%). Average age: 16.5 years; s.d. = 0.9 years. 39% of the respondents are female. Respondents PDA sample: The respondents' age range from 12 to 15. Most of the pupils are 14 years old (54%). Average age: 13 years; s.d. = 0.7 years. 43% is female.

3.2. Reliability of the questionnaire
As recommended [10], the internal consistency reliabilities are higher than 0.7 except from the Application-specific self-efficacy (Blackboard) and the Learning goal orientation (PDA). For research purposes, an ICR of 0.67 is acceptable. Pearson's product-moment correlation coefficients calculated shows that all variables are strongly interconnected. The reliability results and the correlation results provide a good condition to test the Technical Acceptance Model with the regression analyses.

3.3. Comparison of the results of pupils in the Blackboard sample with the results of pupils in the PDA sample
Table 1: The mean score and s.d. from the Blackboard sample compared with the PDA sample

	Blackboard N=160		PDA N=102			
Construct	Mean	s.d.	Mean	s.d.	T	Sig. (2-tailed)
Learning goal orientation	4.47	2.21	7.45	1.53	- 11.80	0.000
Application-specific self-efficacy	4.22	2.37	8.00	1.63	- 14.00	0.000
Enjoyment	4.36	2.55	8.92	1.58	- 16,18	0.000
Ease of use	6.25	1.99	8.11	1.62	- 7.80	0.000
Usefulness	4.85	2.15	7.35	1.95	- 9.34	0.000
Behavioural intention	3.29	2.27	8.07	1.87	- 17,63	0.000

Table 1 shows that the pupils in the Blackboard sample show the highest score on ease of use (mean = 6.25; s.d. = 1.99) and the pupils in the PDA sample show the highest score enjoyment (mean=8.92; s.d. =1.58). The Blackboard sample scored significantly lower than the PDA sample ($p < 0.001$). This supports that hypothesis two is true. The importance of a teacher's own point of view and his/her experience with digital tools is an important factor. Maybe this is an explanation for the good scores in the PDA sample. The pupils' own teacher enthusiastically developed the PDA project herself.

3.4. Comparison females versus males
In the PDA sample females have proved to score significantly better ($p < 0.05$) as regards application specific self efficacy, than males. Mean score males: 7.58, s.d. = 1.81. Mean score females: 8.31, s.d. = 2.21. {Sig. (2-tailed): $p < 0.03$.}. Do girls have more confidence at that age than boys?

### 3.5. Comparison of pupils aged 12-15 with pupil's aged 16-18 Blackboard sample
Pupils aged 16-18 scored significantly higher on application-specific self-efficacy ($p < 0.05$), while pupils aged 12-15 scored significantly higher on enjoyment ($p < 0.05$) and on ease of use ($p < 0.01$). Older pupils have a better understanding of their capabilities. They will sooner realize the benefit of using the com-

puter for their assignments. They already are of the opinion that they are able to cope with the given task. More over, according to Downey [11] self-efficacy has the ability to be enhanced, particularly through training and experience. On the other hand, pupils aged 12-15 scored higher in the Blackboard sample, compared to pupils aged 12-18 on ease of use and enjoyment. Do younger pupils have more experience with computers? Hypothesis three is not true.

3.6. Regression analyses. Measurement of ß-coefficients to test the TAM

The structural model and hypotheses are assessed by examining the significance of the ß-coefficients and the variance accounted for by the antecedent constructs.

Figure 1 Regression analyses to test the proposed model and to compare with the Blackboard sample[1], the PDA sample[2] and with the *ß-coefficients of Yi* [7][3]
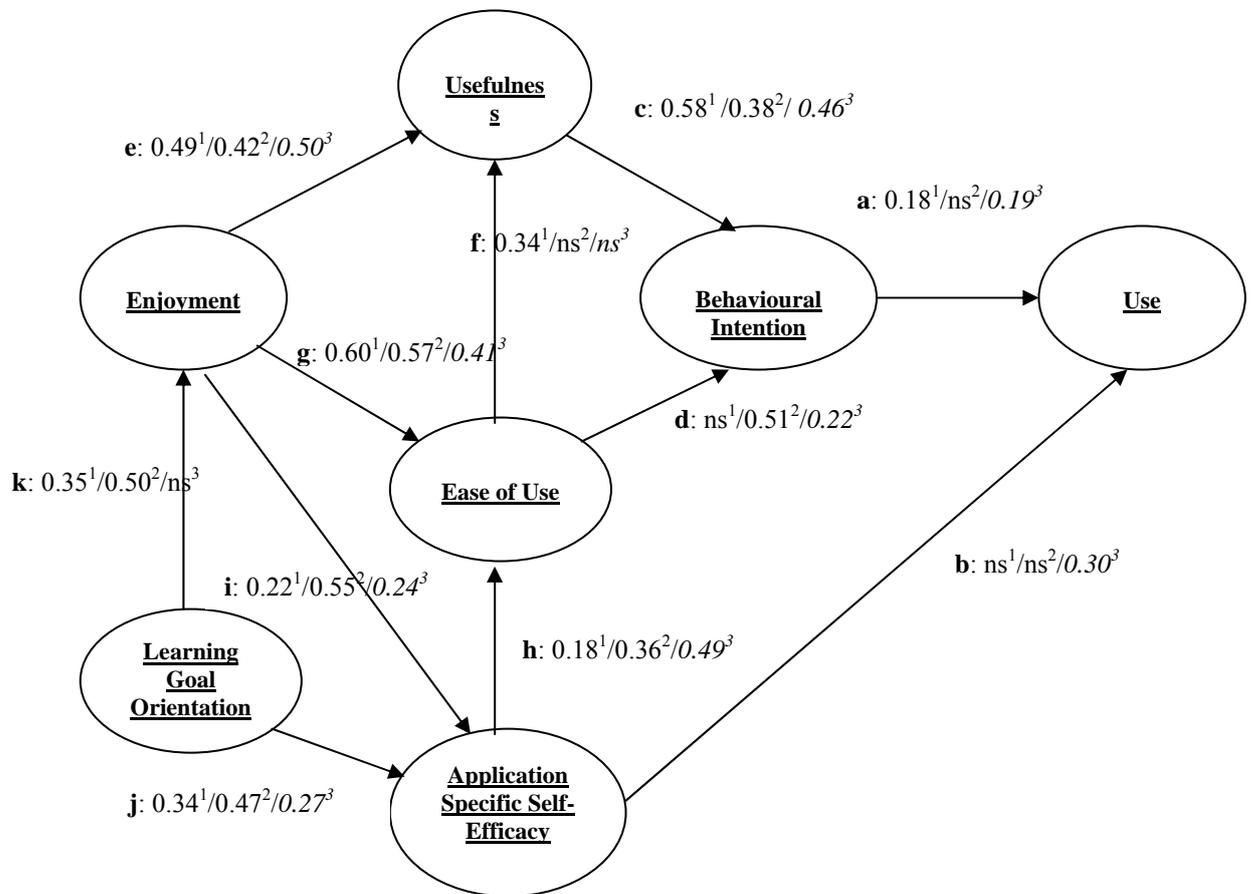
ns = non significant **[1]Blackboard** a: $p<0.05$; h, i: $p<0.01$; c, e, f, g, j, k: $p<0.001$.
[2]PDA e: $p<0.01$; c, d, g, h, i, j, k: $p<0.001$. **[3]**The Italic ß-coefficient are the results out of Yi's research' [7]

Figures 1 provide the results of the regression analysis.

Four out of eleven correlations appear to be different in the Blackboard sample, compared to Yi's research' [7] (b, d, f and k, figure 1). Three out of eleven correlations appear to be different in the PDA sample, compared to the Blackboard sample (a, b and f, figure 1). Since about 80% of the pupils used the PDA system only for the first or second time, the reliability of this correlation is not high, the differ-

ences in usage are minor (ß=0,119, sig=0.114 ns). The remaining differences between the two Dutch investigated samples are d and f (figure 1). Hypothesis 1 is true in general, but there are some differences. On the other hand, there is a considerable degree of similarity as to the pattern and the results of the samples taken in relation to the effect of ease of use on usefulness. The predicting value in both samples and in the American sample therefore shows a strong similarity. How people work and function is altered when new tools are utilized. The field of education has been slow to recognize both the impact of new learning tools and the environmental changes in what it means to learn. Therefore the project 'are you mobile', which allows pupils to work with a PDA, is not only interesting from this point of view, but it also tends to fit with our new generation traits. Sefton-Green [12]: 'Children can get a lot from experiences like games or chat rooms'. She therefore argues to investigate what youngsters really do when they use digital media to create, share, and communicate. Teachers therefore need to take into account the characteristics of the new digital generation of youngsters. They grow up 'on line' so they are called the Net generation.

3.7. Comparison of the results for the Blackboard sample of Dutch pupils with American students

The Dutch pupils show the highest score on ease of use (mean=6.22; s.d. =2.01) and the American students also show the highest score on ease of use too (mean=8.21; s.d. =1.71). The Dutch pupils scored significantly lower than the American students (t>6.31; p<0.10) except for enjoyment. The pattern appears to be the same. In both Blackboard samples, ease of use shows the highest score. Hypothesis four is not true. Dutch pupils do not respond so very well to Blackboard.

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