The relationship between working memory capacity and students' behaviour in a teachable agent-based software

Lisa Palmqvist[1], Camilla Kirkegaard[2], Annika Silvervarg[2], Agneta Gulz[2], Magnus Haake[3]

[1] Dept Behavioural Sciences and Learning, Linköping University, Sweden
[2] Dept. Computer and Information Science, Linköping University, Sweden
[3] Cognitive Science, Lund University, Sweden

Aims

The aim of the current study was to investigate if and how students' behavior in a Teachable-Agent (TA) based educational software differed with respect to their working memory capacity (WMC).

Background

- Learning-by-teaching and TA software is a powerful learning method.
- Educational software in have been suggested to provide off-loading WMC for low-achievers [1].
- It is important to investigate how children with low WMC can benefit from using the software.

TA software

The student takes on the task of teaching a TA in a TA software about history [2]. The software includes the activities:
- Collecting information via dialogues with historic persons (Fig. 1)
- Learning activities (Fig. 2)
- Test-taking by the TA (Fig. 4)
- Off-task activity in the form of an Othello game.

Study design

- Thirty 11-12-year olds played the TA software 2*25 minutes in total.
- The behaviours described in Table 1 were logged by the software.
- Before using the software, a visual, non-lingual Visuo-spatial WMC-test (Fig. 3) [3] measured the children's WMC.
- The highest level completed was used as a measurement of the students WMC (Table 1: *Maximum level achieved in the WMC*).
- 1. A multiple linear regression analysis was performed in order to see which behaviors (Table 1.) in the software could predicted the results of the working memory capacity test.
- 2. A linear regression analysis was performed in order to predict number of correct facts, i.e. an indirect measure of how much the students themselves had learnt.

Table 1. Variables that were logged.

| |
| --- |
| Maximum level achieved in the WMC |
| The total number of visited historical settings by the student |
| The total number of teaching activities engaged in by the student |
| The total number of test engaged by the student |
| Number of rounds of Othello initiated by the student |
| The average time spent in each historical setting |
| Average time spent on each dialogue with the different characters |
| Average time spent playing one round of Othello |
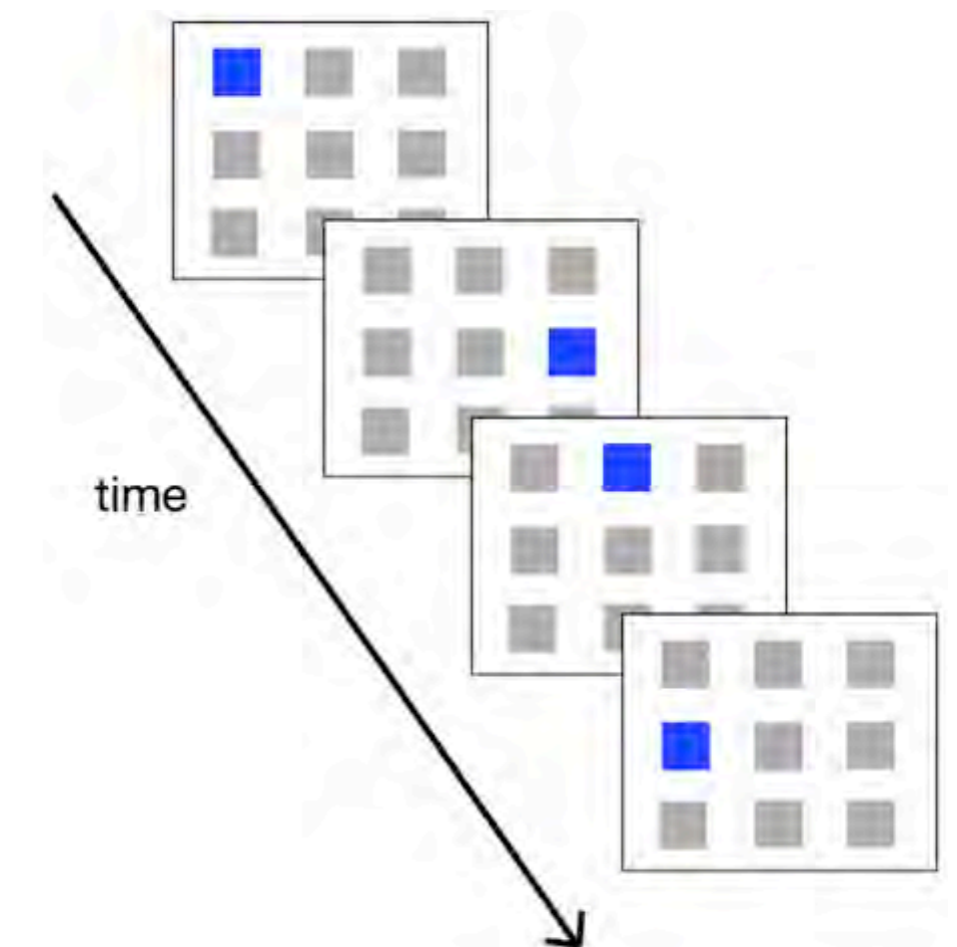
Fig.3 The design of the Visuo-spatial WMC-test

Results

- The result from the multiple regression is shown in Table 2.
- The variables reflect level of ambition, or thoroughness in the use of the software; Children who scored low on the WMC-test spent less time per activity.
- Students with a low WMC capacity may have difficulty in sustaining attention and the results may consequently reflect differences in the ability to keep focus.
- Concerning whether differences in WMC could be associated with differences in how well the students taught the TA, there was a positive but not significant correlation between WMC and total number of correct facts (p=.55) : a study including more participants, who got longer time to use the software might yield a weaker correlation, or the correlation might become stronger depending on what behavior is crucial for successfully teaching the TA.

Table 2. Beta values, standard error, and standardized Beta for the regression model

	B	SE B	β
Constant	3.649	0.682	
The total number of test engaged by the student**	0.092	0.031	.529
Average time spent on each dialogue with the different characters*	0.054	0.023	.404
Average time spent playing one round of Othello*	0.017	0.007	.376

Note. The dependent variable was Maximum level achieved in the WMC; R^2 =.358 for Step 5 (p =.008); *p<.05, **p<.01

Conclusions

- The results address the importance of keeping in mind a broad range of children with differing cognitive abilities when developing novel educational TA software.
- Software benefiting all children from will be a powerful tool for teachers in schools throughout the world.

Fig. 1 The student visits historical settings to gather information.
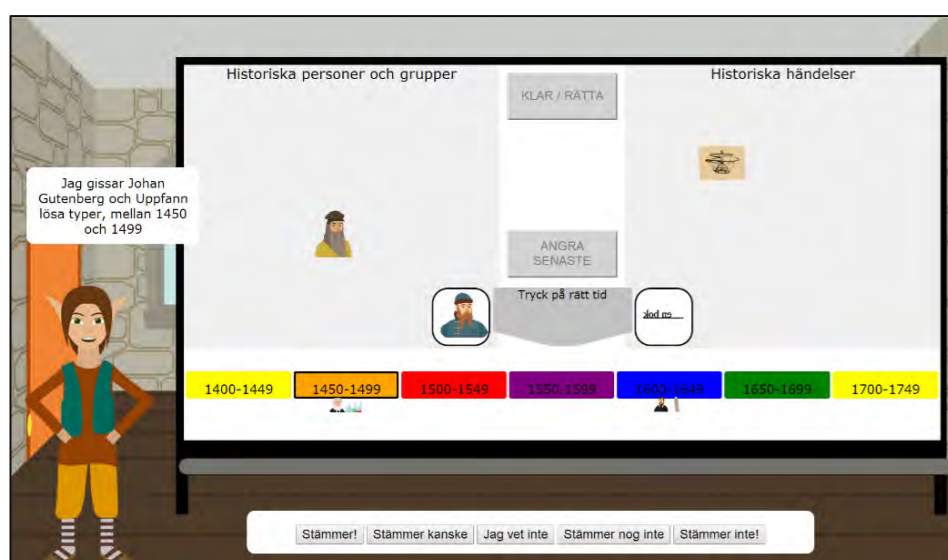
Fig 2. The TA is taught in teaching activities like this one.

References

[1]AZEVEDO, Roger; FEYZI-BEHNAGH, Reza. Dysregulated Learning with Advanced Learning Technologies. In: AAAI Fall Symposium: Cognitive and Metacognitive Educational Systems. (2010)
[2]KIRKEGAARD, Camilla; GULZ, Agneta; SILVERVARG, Annika. Introducing a Challenging Teachable Agent. In: *Learning and Collaboration Technologies. Designing and Developing Novel Learning Experiences*. Springer International Publishing, p. 53-62. (2014)
[3]WESTERBERG, Helena, et al. Visuo-spatial working memory span: A sensitive measure of cognitive deficits in children with ADHD. *Child Neuropsychology*, 10.3: 155-161. (2004)
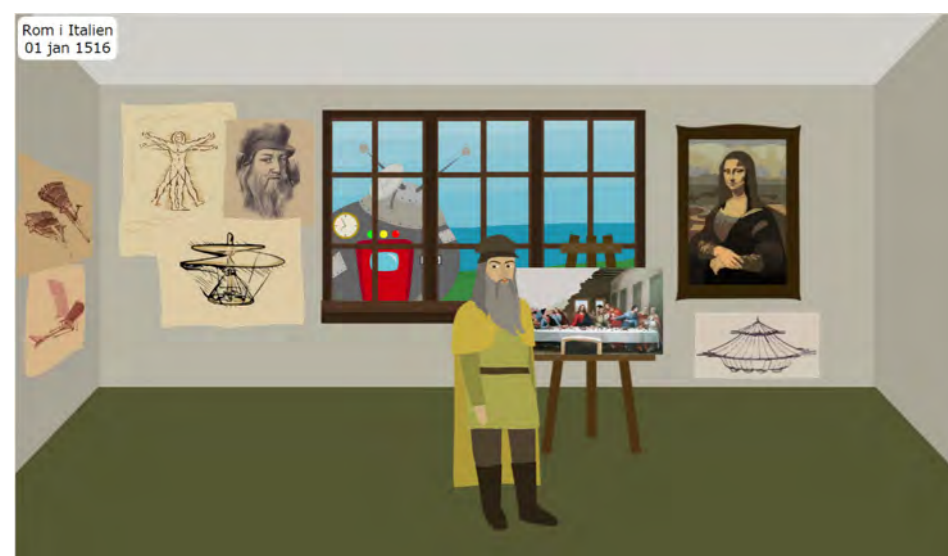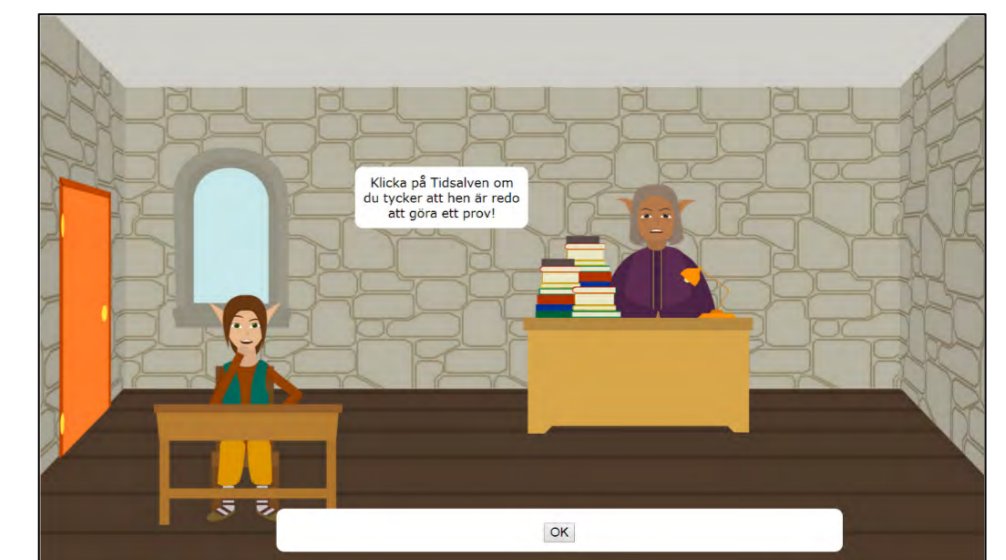
Fig. 4 The TA takes tests to see if it was taught enough.