

# Interactions between Students' Learning Styles, Achievement and Behaviour in Mismatched Courses

**Sabine Graf**

National Central University  
Taiwan  
sabine.graf@ieee.org

**Tzu-Chien Liu**

National Central University  
Taiwan  
ltc@cc.ncu.edu.tw

**Kinshuk**

Athabasca University  
Canada  
kinshuk@ieee.org



# Why do we focus on learning styles?

- Different learners have different learning styles
- Considering learning styles has potential to make learning easier for learners
  - Development of several adaptive systems (AHA!, TANGOW, INSPIRE, ...)
- Two different ways to provide adaptivity based on learning styles
  - Provide students with courses that fit their learning styles → short-term goal
  - Provide students with guidance and help them to develop skills to be able to learn from mismatched courses → long-term goal



# Aim of the study

- Most adaptive systems focus on the short-term goal, namely providing courses which are matched to their learning styles
  - This study focuses on what happens if learning styles are not considered/matched
- Investigate the relationship between students' learning styles, their behaviour in the course, and their achievement in a mismatched course
- o Find out which learners need more help in mastering mismatched courses
  - o Get a better understanding about how students with good and poor achievement learn, considering their learning styles
  - o Provide information about how to identify learners who might have difficulties in learning



# Research Questions

1. Does the strength of learning style preferences have an impact on students' achievement?
2. Which learning styles have an impact on students' achievement?
3. How do students with different learning styles and different achievement behave in a mismatched course and do their strategies give indications about their achievement?



# Felder-Silverman Learning Style Model

- Each learner has a preference on each of the four dimensions:
  - Active – Reflective  
learning by doing – learning by thinking things through  
group work – work alone
  - Sensing – Intuitive  
concrete material – abstract material  
more practical – more innovative and creative  
patient / not patient with details  
standard procedures – challenges
  - Visual – Verbal  
learning from pictures – learning from words
  - Sequential – Global  
learn in linear steps – learn in large leaps  
good in using partial knowledge – need „big picture“



# Felder-Silverman Learning Style Model

- Index of Learning Styles (ILS)  
Questionnaire:
  - Developed by Felder and Soloman
  - 44 questions
  - Result: a value between +11 and -11 for each dimension
- Differences to other learning style models:
  - combine major learning style models
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies



# Experiment Design

- Study was done within a project about enriching learning management systems with adaptivity regarding learning styles
- In the project, learners were divided into 3 groups and presented with a
  - Matched course
  - Mismatched course
  - Standard course
- In this study, we focus only on data from the mismatched course



# Investigated Course

- University course about object-oriented modelling
- Course consisted of
  - Lecture (optional)
  - Practical part - 5 Assignments (compulsory)
  - Online Course in Moodle (optional)
  - Final Exam (compulsory)



# Investigated Course

- Online Course (via Moodle)
  - Content objects
  - Outline
  - Conclusions
  - Examples
  - Self-assessment tests
  - Exercise
  - Forum
- Adaptivity in Online Course
  - Adaptive courses differ regarding
    - number of presented types of learning objects
    - the order in which types of learning objects are presented
  - Adaptive courses acted as recommendation
  - For active/reflective, sensing/intuitive, sequential/global dimension
  - Students were asked to fill out the ILS once they register at Moodle



# Data Analysis

- 3 requirements for data from students in the mismatched course
    - Students need to spend at least 5 minutes for filling out the ILS questionnaire
    - Students need to submit at least 3 assignments (requirement for passing the course)
    - Students need to attend the final exam
- Data from 72 out of 125 students were used for this study



# Impact of Strengths of Learning Styles

## Research Question:

Does the strength of learning style preferences have an impact on students' achievement?

## Method:

- Based on the results of ILS, two groups were built:
  - Students who have a strong learning style preference (greater than +5 or smaller than -5) at least for one dimension
  - Students who have only weak learning style preferences
- Scores of the final exam were used for measuring the achievement



# Impact of Strengths of Learning Styles

Results:

	N	Mean Scores	T	p
One or more strong preferences	39	174.26	<b>2.521</b>	<b>0.014</b>
Only weak preferences	33	190.97		

- Learners with at least one strong learning style preference achieve significantly lower scores than learners with only weak preferences
- Learners with strong learning style preferences need more support in a mismatched course



# Correlations between Learning Styles and Achievement

Research Question:

Which learning styles have an impact on students' achievement?

Method:

Rank correlation analysis between achievement (scores on final exam) and learning style preferences (ILS questionnaire)

# Correlations between Learning Styles and Achievement

Results:

		active/reflective	sensing/intuitive	sequential/global
Kendall	tau	<b>-0.187</b>	-0.063	-0.006
	p	<b>0.028</b>	0.456	0.941
Spearman	rho	<b>-0.266</b>	-0.095	-0.015
	p	<b>0.024</b>	0.425	0.900

→ act/ref dimension is significantly correlated with achievement, indicating that active learners have more problems in mismatched courses than reflective learners



# Students' behaviour in relation to their learning styles and achievement

## Research Question:

How do students with different learning styles and different achievement behave in a mismatched course and do their strategies give indications about their achievement?

## Method:

- Behaviour:
  - Time students spent in the course
  - Number of logins
  - Number of visited learning objects (LO)
  - Number of requests for additional learning objects
- Achievement: scores on final exam (building two groups based on average score)
- Learning style preferences: ILS values (building two groups, using a threshold of 0)



# Students' behaviour in relation to their learning styles and achievement

## Method:

### Analysis 1:

looking at difference in behaviour patterns between students with the same achievement but different learning style preferences on a dimension

e.g., active (high score) and reflective (high score)  
active (low score) and reflective (low score)

### Analysis 2:

looking at differences in behaviour patterns between students with same learning styles but different achievement

e.g., active (low score) and active (high score)  
reflective (low score) and reflective (high score)

### Analysis 3:

looked at correlations between behaviour patterns and achievement for each of the six learning styles



# Summary of Results

- Students with different learning styles and different achievement chose different strategies of behaviour in the mismatched course
- Analysis1:
  - $Seq_{high}$  visited more LOs than  $Glo_{high}$ 
    - sequential learners like to go through the LOs step by step without skipping them
  - $Glo_{low}$  asked more often for additional LOs than  $Seq_{low}$ 
    - although global learners like little guidance, it seems that they easily search too much for additional LOs which has a negative effect on their learning outcome
  - $Seq_{high}$  logged in more often than  $Glo_{high}$
  - $Seq_{low}$  logged in more often than  $Glo_{low}$



# Results

- Analysis2:
  - Ref<sub>high</sub>, Int<sub>high</sub>, and Seq<sub>high</sub> spent more time in the course and visited more LOs than learners with low scores
  - Glo<sub>high</sub> asked less often for additional LOs than Glo<sub>low</sub>

## Analysis1 & Analysis2:

- Show which strategies are used by learners with high and low scores, considering different learning styles
- Only allows to infer behaviour from learning styles and achievement



# Results

- Analysis3 additionally
  - allows to predict the achievement from the behaviour
  - shows which strategies lead to good achievement for each learning style and therefore are able to recommend good strategies
  - shows which strategies lead to poor achievement and helps therefore to identify student who might have difficulties in learning



# Results

- Results show
  - Positive correlation for reflective, sensing and sequential learners between achievement and time as well as number of visited LOs
    - good indicator for identifying learning difficulties/frustration (since their behaviour is then not in line with their typical behaviour)
  - Positive correlation for sequential learners between achievement and requests for additional LOs
    - Shows that seq. learners can benefit from not going step-by-step through a mismatched course (although they would prefer it)



# Conclusions & Future Work

- Investigated the interaction between students' achievement, behaviour and learning styles in a course which was mismatched to students' learning styles
- Results show that
  - Learners with strong learning style preferences have more difficulties
  - Active learners have more difficulties than reflective learners
  - Learners with different learning style and achievement behave differently in the course
  - Differences help in getting a better understanding about the relationship between students' learning styles, behaviour, and achievement
  - Correlations were found between behaviour and achievement for some learning styles, allowing conclusions from the behaviour to the achievement and therefore identifies behaviour which leads to learning difficulties as well as shows which behaviour leads to positive learning outcome



# Conclusions & Future Work

- Results can be used to
  - Identify when students might have difficulties in learning
  - Alert teachers when students seem to have difficulties
  - Provide individual suggestions to the student
- Future Work
  - Extend the study by considering more detailed variables with respect to behaviour
  - Application of the findings by building a tool that identifies when student have difficulties in learning and alert teachers or provide students with individual suggestions

