

Through the eyes of the teacher

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Author Note

The Ethics Advisory Board of Leipzig University has dealt with the research project and has come to the conclusion that there are no objections to the implementation of this research project. The Ethics Advisory Board points out that the scientific and ethical responsibility for the implementation of the project remains with the project director.

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Abstract

12

13 This document is a supplement to the paper and shows first graphs findings from the pilot
14 study.

15 *Keywords:* Professional Vision, Expert-Novice-Paradigm, Eye-Tracking

16 Word count: 1949

Through the eyes of the teacher

State of research

Teaching and classroom management are multidimensional settings in which teachers have to respond immediately to events as they develop (Barnes, 2004). The different interests and abilities of students must be managed in a way that maximizes the active learning time of students and minimizes disruptions whilst teaching. Learning to develop such classroom management skills and to teach effectively is a complicated and complex process (Wolff, Jarodzka, & Boshuizen, 2017).

During teaching, teachers must be able to select from a variety of visual and acoustic impressions to focus their attention on the essential and to distinguish between relevant and irrelevant events. This ability is called professional vision and is a key component of teacher expertise and successful teaching (Barth, 2017). Eye tracking technology has become a reliable means to study teachers' visual focus of attention (Bogert, 2016; Pouta, Lehtinen, & Palonen, 2020; Wolff, Jarodzka, & Boshuizen, 2017)

Educational research has repeatedly shown that there are differences between experienced and novice teachers in terms of perception and behavioral competencies (Barth, 2017; Bogert, 2016; Wolff, Jarodzka, & Boshuizen, 2017). For example, experts direct their attention more often and more evenly to all students, whereas novices only direct their attention to some students. The frequency and duration of fixations as eye movement are decisive (Stuermer, Seidel, Mueller, Häusler, & Cortina, 2017). Mobile eye-tracking technology has also shown that experienced teachers distribute their focus more efficiently to solve tasks (Jarodzka, Scheiter, Gerjets, & Van Gog, 2010). Furthermore, in contrast to novices, experts are able to focus their attention on the entire class and guide the class while giving feedback to individual students and answering questions (Cortina, Miller, McKenzie, & Epstein, 2015).

Research questions

The aim of the pilot study was to investigate whether there are differences in how expert and novice teachers manage scripted classroom disruptions. The disruptions were experimentally varied using a previously written script. Thus, our aim was to find out whether differences in the allocation of attention between expertise groups can be detected in this controlled context.

In order to answer this question, the hypothesis was formulated that teachers with more professional experience not only notice more disruptions but also notice them faster. In the hypothesis, therefore, it is necessary to check what has already been shown in the research literature: In complex teaching situations, experts have a more structured and elaborate professional knowledge than novices in order to perceive and interpret relevant events and to act appropriately (Berliner, 2001; Lachner, Jarodzka, & Nückles, 2016).

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

For the sample recruitment of the subjects ($N = 8$, experts $n = 2$, novices $n = 6$), schools in the city of Leipzig in Saxony were contacted. The institutions as well as the subjects were informed in detail about the aim and intention of the study in advance. Participation in the study was voluntary and only took place after written consent has been given.

The selection of the subjects was based on extreme groups, whereby professional experience is the crucial criterion for the selection of experts or novices. Novices were recruited as teachers who have been working in the teaching profession for no more than 3

Table 1

Demographic Information and Teaching Experience

group	N	Male	M age	Min age	Max age	SD age	M exp.	Min exp.	Max exp.	SD exp.
expert	2	1	47.50	44	51	4.95	20.00	15.00	25.00	7.07
novice	6	2	25.67	20	33	4.89	0.68	0.00	1.50	0.68

years, whereas experts were considered to have professional experience of 10 years or more (Messner & Reusser, 2000).

Procedure/ Data collection

Set up. For this study, scripted mini-lessons with $n = 2$ experts and $n = 6$ novices were recorded in the mobile Lab of the Empirical School and Classroom Research at the University of Leipzig. The subjects were divided into groups of four, so the study was conducted on two different sessions. All participants were asked to hold a 10-minute lesson. The duration of each appointment was approximately 2h: per group 10min briefing, 4 x 10min mini-lessons, 10min technical preparation and follow-up and 4x 10min transition points between the lessons and answering questionnaires.

One person from the group of 4 acted as a teacher, the other three subjects acted as the class. The subjects, who represented the class, were given behavioral instructions in a pre-written script to simulate typical events and disruptions in the classroom (e.g. putting their heads on the table, chatting, looking at their mobile phones, etc.).

The lesson disruptions were displayed as instructions during the lesson for all “students” but not the teacher. In order to avoid learning effects, the disruptions in each lesson were distributed pseudo-randomly over the short teaching phase. In addition, the order of the data collection was taken into account in the analyses and variance caused by

84 order was controlled.



Figure 1. Example for set up during a mini-lesson

85 **Eyetracking data.** A binocular Tobii Pro Glasses 2 eye-tracker consisting of a
86 wearable head unit and a recording unit was used to record the eye movements of all 8
87 participants. The head unit is a measuring device with different sensitive sensors. A
88 high-definition scene camera captures a full HD video and an integrated microphone
89 records the surrounding sounds. Infrared light illuminators support the eye tracking
90 sensors which record the eye orientation. The videos were recorded with a sampling rate of
91 50 Hz and a video resolution with 1920 x 1080 at 25 frames per second. The scene camera
92 has a field of view of 90 deg. in 16:9 format (82 deg. horizontal and 52 deg. vertical) and
93 has a frame dimension of 179 x 159 x 57mm (width x depth x height). The Tobii Pro
94 Glasses Controller software was used to record and calibrate the eye movements.

Coding/ Data preparation/ Reliability

Eyetracking Data. The Tobii Pro Lab 2 software was used to analyze the teachers' visual attention during each mini-lesson. The software allows for non-screen based recordings of a participants' attention while moving in real-world settings. The recordings of the glasses contain both HD-video from the subjects' perspective as well as the respective gaze data mapped onto the video. In order to map multiple recordings to AOIs, we first imported the eye-tracking recordings into the Tobii Pro Analyzer software. Second, we created dynamic Areas of Interest (AOI) manually to plot the gaze data. Once the AOIs are created, the gaze recordings of multiple recordings can be mapped and analyzed in aggregated form. Tobii Pro does not allow to do AOI based analyses within Pro Lab. So we exported a tsv. file to do further analyses in the software R.

Gaze relational index (GRI).

The GRI is a measure of visual expertise in information processing. This metric is calculated as the ratio of mean fixation duration to fixation count. The GRI is higher for novices than for experts. (Gegenfurtner et al., 2020)

The first table provides an overview over the

Data analysis

We used R [Version 4.0.3; R Core Team (2019)] and the R-packages *dplyr* [R-dplyr], *corrplot2017* (Wei & Simko, 2017), *forcats* [Version 0.5.0; Wickham (2020a)], *Formula* [Version 1.2.4; Zeileis and Croissant (2010)], *ggplot2* [Version 3.3.2; Wickham (2016)], *Hmisc* [Version 4.4.2; Harrell Jr, Charles Dupont, and others. (2020)], *lattice* [Version 0.20.41; Sarkar (2008)], *moments* [Version 0.14; Komsta and Novomestky (2015)], *papaja* [Version 0.1.0.9997; Aust and Barth (2020)], *papayar* (Muschelli, 2016), *psych* [Version 2.0.12; Revelle (2020)], *purrr* [Version 0.3.4; Henry and Wickham (2020)], *readr* [Version 1.4.0; Wickham, Hester, and Francois (2018)], *sjPlot* [Version 2.8.7; Lüdtke

(2021)], *stringr* [Version 1.4.0; Wickham (2019)], *survival* [Version 3.2.7; Terry M. Therneau and Patricia M. Grambsch (2000)], *tibble* [Version 3.0.4; Müller and Wickham (2021)], *tidyr* [Version 1.1.2; Wickham (2020b)], and *tidyverse* [Version 1.3.0; Wickham et al. (2019)] for all our analyses.

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Questionnaire Data.

Behavioral Data.

Eyetracking Data.

Results

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Questionnaire Data.

Behavioral Data.

Eyetracking Data.**Discussion**

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Table 2

GRI

TOI	ID	Group	DurTOI	M Dur Fix	Number Fix	TimeTOI Dur	OldGRI	NewGRI
Asking question	01_04_C	Novice	3,869.00	2,925.62	3.00	1.32	975.21	0.44
Asking question	01_02_A	Expert	7,112.00	2,925.62	13.00	2.43	225.05	0.19
Asking question	01_03_B	Novice	12,863.00	2,925.62	4.00	4.40	731.41	1.10
Asking question	01_01_D	Expert	7,648.00	2,925.62	7.00	2.61	417.95	0.37
Asking question	02_01_A	Novice	7,422.00	2,925.62	3.00	2.54	975.21	0.85
Asking question	02_02_B	Novice	7,082.00	2,925.62	9.00	2.42	325.07	0.27
Asking question	02_03_C	Novice	8,045.00	2,925.62	8.00	2.75	365.70	0.34
Asking question	02_04_D	Novice	6,595.00	2,925.62	6.00	2.25	487.60	0.38
Calibration phase	01_04_C	Novice	17,224.00	12,275.12	14.00	1.40	876.79	0.10
Calibration phase	01_02_A	Expert	13,335.00	12,275.12	10.00	1.09	1,227.51	0.11
Calibration phase	01_03_B	Novice	10,615.00	12,275.12	17.00	0.86	722.07	0.05
Calibration phase	01_01_D	Expert	16,470.00	12,275.12	9.00	1.34	1,363.90	0.15
Calibration phase	02_01_A	Novice	17,902.00	12,275.12	13.00	1.46	944.24	0.11
Calibration phase	02_02_B	Novice	12,325.00	12,275.12	12.00	1.00	1,022.93	0.08
Calibration phase	02_03_C	Novice	16,494.00	12,275.12	18.00	1.34	681.95	0.07
Calibration phase	02_04_D	Novice	20,964.00	12,275.12	14.00	1.71	876.79	0.12
Chatting with neighbour	01_04_C	Novice	9,843.00	4,070.12	27.00	2.42	150.75	0.09
Chatting with neighbour	01_02_A	Expert	2,607.00	4,070.12	1.00	0.64	4,070.12	0.64
Chatting with neighbour	01_03_B	Novice	11,060.00	4,070.12	10.00	2.72	407.01	0.27
Chatting with neighbour	01_01_D	Expert	6,612.00	4,070.12	3.00	1.62	1,356.71	0.54
Chatting with neighbour	02_01_A	Novice	7,429.00	4,070.12	5.00	1.83	814.02	0.37
Chatting with neighbour	02_02_B	Novice	8,397.00	4,070.12	11.00	2.06	370.01	0.19
Chatting with neighbour	02_03_C	Novice	11,713.00	4,070.12	11.00	2.88	370.01	0.26
Chatting with neighbour	02_04_D	Novice	11,443.00	4,070.12	4.00	2.81	1,017.53	0.70
Clicking pen	01_04_C	Novice	12,980.00	8,809.75	4.00	1.47	2,202.44	0.37
Clicking pen	01_02_A	Expert	12,071.00	8,809.75	20.00	1.37	440.49	0.07
Clicking pen	01_03_B	Novice	26,272.00	8,809.75	16.00	2.98	550.61	0.19
Clicking pen	01_01_D	Expert	11,597.00	8,809.75	11.00	1.32	800.89	0.12
Clicking pen	02_01_A	Novice	16,114.00	8,809.75	11.00	1.83	800.89	0.17
Clicking pen	02_02_B	Novice	9,409.00	8,809.75	12.00	1.07	734.15	0.09
Clicking pen	02_03_C	Novice	16,269.00	8,809.75	27.00	1.85	326.29	0.07
Clicking pen	02_04_D	Novice	24,220.00	8,809.75	19.00	2.75	463.67	0.14
Drawing on paper	01_04_C	Novice	39,979.00	34,414.38	27.00	1.16	1,274.61	0.04
Drawing on paper	01_02_A	Expert	44,971.00	34,414.38	87.00	1.31	395.57	0.02
Drawing on paper	01_03_B	Novice	129,708.00	34,414.38	79.00	3.77	435.62	0.05
Drawing on paper	01_01_D	Expert	74,511.00	34,414.38	92.00	2.17	374.07	0.02
Drawing on paper	02_01_A	Novice	43,469.00	34,414.38	31.00	1.26	1,110.14	0.04
Drawing on paper	02_02_B	Novice	147,788.00	34,414.38	295.00	4.29	116.66	0.01
Drawing on paper	02_03_C	Novice	26,495.00	34,414.38	46.00	0.77	748.14	0.02
Drawing on paper	02_04_D	Novice	27,915.00	34,414.38	11.00	0.81	3,128.58	0.07
Drumming hands	01_04_C	Novice	43,507.00	11,415.88	41.00	3.81	278.44	0.09
Drumming hands	01_02_A	Expert	20,530.00	11,415.88	27.00	1.80	422.81	0.07
Drumming hands	01_03_B	Novice	12,615.00	11,415.88	6.00	1.11	1,902.65	0.18
Drumming hands	01_01_D	Expert	23,121.00	11,415.88	17.00	2.03	671.52	0.12
Drumming hands	02_01_A	Novice	62,326.00	11,415.88	50.00	5.46	228.32	0.11
Drumming hands	02_02_B	Novice	24,699.00	11,415.88	25.00	2.16	456.64	0.09
Drumming hands	02_03_C	Novice	27,775.00	11,415.88	49.00	2.43	232.98	0.05
Drumming hands	02_04_D	Novice	14,998.00	11,415.88	9.00	1.31	1,268.43	0.15
Looking at phone	01_04_C	Novice	7,984.00	11,563.00	8.00	0.69	1,445.38	0.09
Looking at phone	01_02_A	Expert	19,897.00	11,563.00	28.00	1.72	412.96	0.06
Looking at phone	01_03_B	Novice	40,427.00	11,563.00	30.00	3.50	385.43	0.12
Looking at phone	01_01_D	Expert	32,387.00	11,563.00	29.00	2.80	398.72	0.10
Looking at phone	02_01_A	Novice	33,557.00	11,563.00	14.00	2.90	825.93	0.21
Looking at phone	02_02_B	Novice	16,321.00	11,563.00	19.00	1.41	608.58	0.07
Looking at phone	02_03_C	Novice	28,223.00	11,563.00	47.00	2.44	246.02	0.05
Looking at phone	02_04_D	Novice	31,944.00	11,563.00	19.00	2.76	608.58	0.15

Table 3

GRI

Group	TOI	M Fixation Duration	M Number Fixation	M TOI	M Old GRI	SD Old GRI	M New GRI	SD New GRI
Expert	Asking question	2,108.50	10.00	7,380.00	231.70	98.30	0.39	0.18
Expert	Calibration phase	12,283.00	9.50	14,902.50	1,296.54	96.50	0.13	0.03
Expert	Chatting with neighbour	1,829.00	2.00	4,609.50	1,219.33	862.20	1.32	0.16
Expert	Clicking pen	5,416.50	15.50	11,834.00	381.62	156.68	0.15	0.06
Expert	Drawing on paper	25,514.50	89.50	59,741.00	285.30	11.27	0.03	0.01
Expert	Drumming hands	8,405.00	22.00	21,825.50	402.85	129.48	0.13	0.05
Expert	Looking at phone	8,484.50	28.50	26,142.00	297.79	7.39	0.11	0.03
Expert	Putting head on table	7,605.50	15.50	14,878.00	1,091.53	1,145.29	0.16	0.07
Expert	Yelling	580.00	1.00	2,120.00	580.00	0.00	3.66	0.30
Novice	Asking question	3,198.00	5.50	7,646.00	703.26	320.81	0.51	0.30
Novice	Calibration phase	12,272.50	14.67	15,920.67	853.95	130.15	0.09	0.03
Novice	Chatting with neighbour	4,817.17	11.33	9,980.83	617.28	384.64	0.26	0.18
Novice	Clicking pen	9,940.83	14.83	17,544.00	955.00	774.90	0.15	0.09
Novice	Drawing on paper	37,381.00	81.50	69,225.67	1,233.52	1,156.72	0.04	0.02
Novice	Drumming hands	12,419.50	30.00	30,986.67	791.90	760.35	0.10	0.04
Novice	Looking at phone	12,589.17	22.83	26,409.33	747.59	459.89	0.10	0.05
Novice	Putting head on table	20,198.00	44.50	40,305.33	535.53	252.70	0.04	0.02
Novice	Yelling	992.67	2.83	6,611.83	635.78	409.08	4.76	4.60

Table 4

GRI

Group	M Fixation Duration	M Number Fixation	M TOI	M Old GRI	SD Old GRI	M New GRI	SD New GRI
Expert	8,025.17	21.50	18,159.17	1,953.05	2,871.09	0.16	0.08
Novice	12,645.43	25.33	24,958.93	1,878.32	2,902.64	0.13	0.15

Table 5

Number and Duration (in msec) of Fixations during calibration

Participant	Variable1	Fixation Number	Fixation Duration	M Duration Fixation	TOI	GRI
01_01_D	Expert	9.00	14,372.00	1,597.00	16,470.00	177.44
01_02_A	Expert	10.00	10,194.00	1,019.00	13,335.00	101.90
01_03_B	Novice	17.00	9,234.00	543.00	10,615.00	31.94
01_04_C	Novice	14.00	15,311.00	1,094.00	17,224.00	78.14
02_01_A	Novice	13.00	5,157.00	397.00	17,902.00	30.54
02_02_B	Novice	12.00	10,654.00	888.00	12,325.00	74.00
02_03_C	Novice	18.00	14,151.00	786.00	16,494.00	43.67
02_04_D	Novice	14.00	19,128.00	1,366.00	20,964.00	97.57

Table 6

Number and Duration (in msec) of Fixations Calibration End to Lesson Start

Participant	Variable1	Fixation Number	Fixation Duration	M Duration Fixation	TOI	GRI
01_01_D	Expert	101.00	38,177.00	378.00	53,133.00	3.74
01_02_A	Expert	27.00	6,736.00	249.00	15,502.00	9.22
01_03_B	Novice	57.00	36,378.00	638.00	58,763.00	11.19
01_04_C	Novice	65.00	22,387.00	344.00	39,235.00	5.29
02_01_A	Novice	14.00	2,619.00	187.00	30,195.00	13.36
02_02_B	Novice	46.00	15,851.00	345.00	30,297.00	7.50
02_03_C	Novice	86.00	27,643.00	321.00	42,603.00	3.73
02_04_D	Novice	53.00	27,783.00	524.00	36,204.00	9.89