Using Zoom Avatars to Weaken Zoom Fatigue in Tertiary Education

Gerhard Hube, Nicholas H. Mueller, Christian Moellmann, Hakan Arda
Faculty of Economics and Business Administration and
Faculty of Computer Science and Business Information Systems
University of Applied Sciences Wuerzburg-Schweinfurt
Wuerzburg, Germany
e-mail: gerhard.hube@fhws.de, nicholas.mueller@fhws.de, christian.moellmann@study.thws.de, hakan.arda@thws.de

***Abstract* — As a result of the Corona pandemic, universities and other educational institutions were forced to switch completely to online teaching and distance learning, primarily using video conferencing systems such as Zoom, Microsoft Teams and Google Meet. Due to the lack of personal participation and the limitations of video conferencing technology, students experienced Fatigue and an increasingly declining motivation and ability to concentrate. The term "Zoom Fatigue" has become established for this phenomenon and has already been addressed in numerous studies at universities, dealing with several Fatigue symptoms in online classes. This study examines the extent to which at least some of the factors that cause Zoom Fatigue could be avoided or mitigated by using Avatar-based virtual learning environments in higher education. As part of a module in the master's program "Integrated Innovation Management" at the University of Applied Sciences in Würzburg, various desktop-based teaching environments were used (face-to-face, Zoom with camera, Zoom with Avatar) and then evaluated via a survey. When using the Zoom Avatars, some of the known Zoom Fatigue causes were specifically avoided. As predicted, the results show that the usage of Zoom Avatar environment has significantly lower perceived Fatigue than Zoom camera environment. Surprisingly, the value for General exhaustion was highest for the face-to-face program, what we call 'self-motivated Fatigue' because face-to-face is clearly preferred by the students. Further analyses on the use of virtual environments with higher immersion (gather.town, framevr.io) are planned.**

Keywords - Virtual Learning Environments; Online Teaching; Tertiary Education; 2D and 3D Avatar-Based Desktop-Environments; Desktop virtual reality; Zoom Fatigue.

I. INTRODUCTION

The use of online courses and distance learning was the result of the corona pandemic, especially in the years 2020 to 2022 [1] with the primary use of classic video conferencing tools [2], [3]. Besides the advantage that lectures and courses could be given instead of cancelling, the longtime usage of this Video Conferencing tools caused specific symptoms of exhaustion among the participants [4], [5]. These symptoms of exhaustion, like declining motivation, decreasing ability to concentrate, and even headaches and visual disturbances, become established under the term "Zoom Fatigue" [6]-[8]. Even after the lockdowns and the Corona measures were lifted, online meetings and courses were and continue to be used on an increased scale, primarily using video conferencing systems [9], [10]. Therefore, it can be assumed that the effects of Zoom Fatigue are effective to an increased extent and affect students to a considerable extent. The present study examines the extent to which at least some of these factors, like the discomfort of always seeing yourself as a camera image or the feeling of always being watched by others, could be avoided or mitigated using Avatar-based virtual learning environments in higher education. So far, several studies have established both the basic suitability and various advantages of such worlds [11]-[14], but so far, there has been no specific investigation into the extent to which Avatar-based environments have the potential to reduce Zoom Fatigue.

To get a realistic picture, the challenge was to analyze not only one or two sessions but at best, a complete lecture or module within tertiary education. Ideally, the students should be the same, and the software should be accessible to all and run on their own computers. To solve these difficulties, a whole lecture with the same students from one semester was used and by using the known and familiar Zoom software, there were no technical issues. The idea of the research design is to regularly change the teaching environment. Therefore, two courses were always held in each environment and then directly assessed by the students. This was intended to answer the research question of whether different environments change perceptions of Fatigue and whether Avatars can improve these perceptions. The purpose of this study, including the research before, is to analyze alternatives for classical video conferencing systems to find recommendations for future online courses at universities [12]-[14]. The limitation is the small number of participants because we are dealing with an exploratory case study and, therefore, the results cannot be Generalized at all.

Within Section I, a short overview of Zoom Fatigue causes is given in subchapter A. and Zoom Fatigue symptoms in subchapter B. within the Introduction. Section II takes a look at related work. Section III describes the differently used learning environments, Classroom teaching in subchapter A, Zoom with video in subchapter B., and Zoom with Avatars in subchapter C. Subchapter D. and E. explain the measuring instrument, experimental procedure, and the sample. The first results can be shown in Section IV and then discussed in Section V. The paper ends in Section VI with conclusions and future work within this research area.

A. *Zoom Fatigue Causes*

The causes of this Fatigue are manifold and range from poor image and sound quality to information overload and a disturbing feeling due to the constant mirror image of the video camera [15]-[17]. Many people who use virtual meetings from Zoom, Skype, Teams, or other providers find virtual conferences more stressful and tiring than real meetings [15]. There may be various reasons for this, which can be seen in Figure 1 [15].

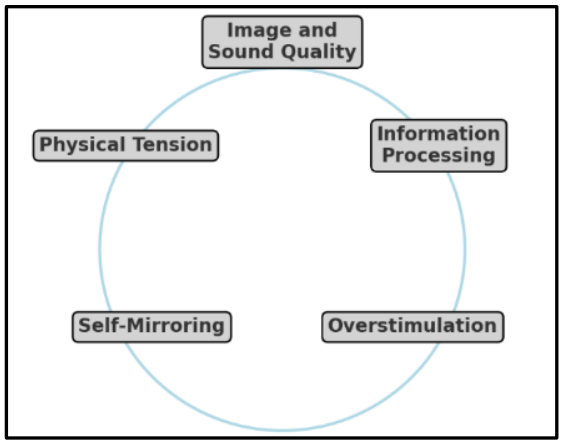

Figure 1. Zoom Fatigue Causes.

The fact that participants see themselves reflected in the video is one of the causes of Zoom Fatigue. This can subconsciously trigger stress, which is also caused by physical tension [17]. A non-verbal behavior of these relationships is expressed by the fact that people who are strangers usually keep a certain distance from each other and avert their eyes as soon as they meet in a confined space [18]. This non-verbal behavior changes on virtual video platforms, as eye contact is inevitable. The speaker view, in which one of the people appears larger on the screen and the others in smaller tiles above, increases this discomfort, as the personal distance to other people is perceived as too close [15], [19].

B. *Zoom Fatigue Symptoms*

The symptoms of Zoom Fatigue can manifest themselves on both a psychological and physical level [20]. The Universities of Stanford and Gothenburg and the Institute of Occupational Medicine have investigated the topic and have concluded that a variety of impairments can occur. These are listed in more detail in Table 1 [21].

TABLE I. ZOOM FATIGUE SYMPTOMS

Psychological Symptoms	Physical Symptoms
Reduced concentration	Headache
Restlessness	Back pain
Irritability	Vision problems
Lack of balance	Sleep problems

12% of respondents stated in a corresponding study that Zoom Fatigue was always present, while 83.3% said it was regularly the case [15]. It was found that it was not the number of virtual events that was decisive but above all the respective implementation and design. For female respondents in particular, the researchers concluded that seeing themselves in video meetings led to a greater state of Fatigue [15]. This could be because they were more aware of how others perceived them [22]. The relationship between the real-time transmission of Zoom and the higher awareness of self-evaluation is referred to as the “screen-mirror effect” [8]. The mode of self-viewing in Zoom or other virtual video conferencing systems can act as a trigger that increases social anxiety through negative self-images as participants subconsciously compare their behavior or appearance to ideal standards [8].

II. RELATED WORK

The scientific debate on the topic of Zoom Fatigue has become increasingly important due to the causes and symptoms described above. Various studies are already dedicated to analyzing its cause, effects, and possible countermeasures, particularly in the university and college environment. A study from 2022 analyzed how video conferencing Fatigue is associated with symptoms of burnout and depression. The results indicate that people with a tendency towards emotional instability and negative emotions are at increased risk of burnout and depression symptoms due to frequent video conferencing. The authors emphasize that the frequent feeling of being overwhelmed by video conferencing causes not only physical but also mental exhaustion [23]. Another study found that Zoom Fatigue is particularly prevalent among students and teachers who must complete many digital events over a longer period. The qualitative analysis showed that the subjective perception of Fatigue is often exacerbated by technical problems, lack of social interaction, and the duration of the sessions [22]. A study of medical students who regularly used video conferencing systems during the Covid-19 pandemic found that a significant proportion of students suffered from symptoms of Fatigue [24]. The findings highlight the need to develop strategies to minimize the negative impact of online learning environments on students' well-being. The study often focuses on short-term objectives and not long-time online lectures for a whole semester [11]. Therefore, this study analyses a regular course over an entire semester with changing teaching and learning environments to get a realistic picture of perceived Fatigue for students.

III. METHOD

In the following, we present the different environments which were used for the first results of this study. These are the classroom environment for face-to-face teaching (subchapter A.), Zoom with camera tiles (subchapter B.), and Zoom with Avatars (subchapter C.). Subchapter D. contains the Measuring instruments, subchapter E. describes the experimental procedure and subchapter F. explains the Sample.

A. *Classroom Environment for face-to-face teaching*

The face-to-face teaching was given in some bigger seminar rooms for front-end lectures alternated with group

work in smaller rooms for 5 to 6 people. All rooms have natural light with big windows and flexible furniture. Figure 2 gives an impression of the seminar room style.

Figure 2. Seminar rooms for front end in the upper part and group work in the lower part of the picture.

B. *Zoom with video tiles*

Zoom is one of the Classic Video Conferencing Tools with quite widespread usage for education, especially during the COVID-19 pandemic [9]. Zoom allows for one or more people to interact through video-based visual and audio communication, and chat communication [25]. It is also possible to create subgroups (Break-out rooms) for group work or group discussions. There is also the possibility to share the screen with other participants, to do little surveys, and to use a whiteboard. The classic appearance is the monitor full of video tiles with the participants of the Zoom meeting, as shown in Figure 3.

Figure 3. Video tiles on monitor for classical zoom video lecture.

C. *Zoom with Avatars*

Besides the classic use of video tiles to enable visual interaction during meetings or lectures, Zoom also offers the option to represent participants through Avatars. These Avatars can be customized, ranging from simple animal representations to advanced humanoid figures that reflect users' facial expressions—and in some cases, their gestures—in real time. Customization options include not only skin tone, hairstyle, and clothing, but also detailed facial features [26]. Importantly, Zoom Avatars are not static: they display facial expressions and certain movements while speaking. For example, gestures such as a wide-open mouth, laughter, head shaking, or nodding are automatically mirrored by the Avatar. This creates a dynamic rather than static appearance, which is relevant for interpreting the results of this study. In this context, only humanoid Avatars were used to maintain the professional character of the lecture, although Zoom also offers playful options such as animal or fantasy Avatars. Figure 4 illustrates the appearance of the Zoom Avatar function as used in this study.

Figure 4. Zoom monitor screen with Avatar tiles.

D. *Measuring Instrument*

The questionnaire that was used includes several parts to measure topics for Zoom Fatigue, learning motivation, communication, and General issues. In this paper, only the Zoom Fatigue questions are presented, because the initial results are focused on that. Future publications will include the other measurement instruments also. The Stanford Virtual Human Interaction Lab developed a scale (ZEF scale) that aims to systematically assess the specific stress and Fatigue symptoms that arise from the intensive use of video conferencing [27]. The ZEF scale is divided into 5 “Constructs” and 3 questions each. Based on this scale, 5 questions were selected, one from each “Construct”, to obtain a comprehensive impression but, at the same time, to limit the scope of the questions. To include also Zoom Fatigue causes four questions were added. The first asks about the lack of opportunities for informal communication and the second about stimulating and inspiring aspects of the environment [20]. The third question is about the discomfort of constantly seeing one's own image in the video tile, and the fourth addresses the feeling of being watched by others. All items were measured using a 5-point Likert scale. The whole questionnaire is shown in Table II.

E. *Experimental procedure*

The study was done within the lecture “trend analysis and innovation assessment” (Trend) of the master study program “Integrated Innovation Management” at the Technical University of Applied Sciences Würzburg-Schweinfurt Germany. The lecture was given in the winter semester from October 2024 until December 2024, for 6 days. The seminar

duration was always from 9:00 a.m. to 1:15 p.m. The first two lecture dates were given in the classroom as face-to-face teaching. The following two lecture dates were given online with Zoom using the classical video tiles configuration. For the last two lecture dates, it was switched to the Zoom Avatar style. The three measurement time points were always conducted immediately after the end of each of the three different sections of learning environments via an online questionnaire. The questions were given in German language.

TABLE II. QUESTIONNAIRE FOR ZOOM FATIGUE SYMPTOMS AND CAUSES

Zoom fatigue symptoms			
Item/Question	1	General fatigue	I felt exhausted after a lecture
Item/Question	2	Visual fatigue	I had visual problems after a lecture
Item/Question	3	Social fatigue	After a lecture, I avoided social situations
Item/Question	4	Motivational fatigue	After a lecture, I felt like doing nothing
Item/Question	5	Emotional fatigue	I felt emotionally drained after a lecture
Zoom fatigue causes			
Item/Question	6	Networking Opportunities	In the virtual environment, I had opportunities for informal exchange and networking.
Item/Question	7	Stimulating environment	I found the virtual environment stimulating and inspiring.
Item/Question	8	Self-mirroring	I found it uncomfortable to constantly see myself on the screen.
Item/Question	9	Feeling observed	I feel uncomfortable thinking that others are observing my video image.

F. Sample

A total of 17-20 subjects participated in the three measurement time points (average of 18.33). The average age of the subjects is 24.85 years, with a minimum of 22 years and a maximum of 30 years. The gender distribution was 8-9 males and 9-11 females.

IV. RESULTS

The results section is divided into different chapters. First, there is an analysis of the descriptive statistical data in subchapter A. Subchapter B. contains several variance analyses to see if there are significant differences between the three different learning environments in terms of Zoom Fatigue items based on the ZEF scale. To analyze possible relationships between the symptoms and causes of Zoom Fatigue, the results of a regression analysis are presented in subchapter C.

A. Analysis of Descriptive Statistic

As described in Section III, three different learning environments were used in the lecture Trend, face-to-face teaching, Zoom with camera, and Zoom with Avatars. All environments were used within two lecture dates each from 09:00 a.m. - 1:15 p.m. Generally, the level of Fatigue is not quite high regarding the maximum scale of 5. Only two items get above 3.5, as shown in Table III. These are the General Fatigue at face-to-face teaching with 3.60 and General Fatigue with Zoom camera with 3.53. All the other Fatigue items are between 1.76 for Visual Fatigue with face-to-face teaching and 2.72 for General Fatigue with Zoom Avatar. Looking at the average values for each Fatigue item above the three different environments, the range is between 3.29 for General Fatigue and 2.00 for Visual Fatigue. Overall, it can be said that only a moderate level of exhaustion could be measured with almost always under 3.00 except for the General Fatigue.

TABLE III. DESCRIPTIVE ANALYSIS ZOOM FATIGUE SYMPTOMS

Learning environment	N	Mean	Standard Deviation	Minimum	Maximum
General fatigue					
face-to-face teaching	20	3.60	0.883	2	5
Zoom Camera	17	3.53	0.874	1	4
Zoom Avatar	18	2.72	0.752	1	4
Total	55	3.29	0.916	1	5
Visual fatigue					
face-to-face teaching	17	1.76	0.903	1	4
Zoom Camera	17	2.24	1.033	1	4
Zoom Avatar	18	2.00	0.767	1	3
Total	52	2.00	0.907	1	4
Social fatigue					
face-to-face teaching	20	2.00	1.026	1	5
Zoom Camera	16	2.31	1.138	1	4
Zoom Avatar	18	1.94	0.802	1	3
Total	54	2.07	0.988	1	5
Motivational fatigue					
face-to-face teaching	19	2.37	1.065	1	5
Zoom Camera	17	2.41	1.121	1	4
Zoom Avatar	18	2.17	0.786	1	4
Total	54	2.31	0.987	1	5
Emotional fatigue					
face-to-face teaching	20	2.60	1.142	1	5
Zoom Camera	16	2.69	1.014	1	4
Zoom Avatar	18	2.11	0.963	1	4
Total	54	2.46	1.059	1	5

B. Analysis of Variance for Significant Differences

In the next section, the 5 items on the Zoom Fatigue symptoms are tested for differences between the mean values of the three surveys using a single-factor analysis of variance (ANOVA). As the number of test subjects was less than 30, the rank variance analysis according to Kruskal & Wallis (H-test) was also calculated in addition to the single-factor analysis of variance. In the single-factor analysis of variance, only the assessment of General exhaustion was found to be significant ($p = 0.004$). The effect size η^2 is 0.14 and can, therefore, be categorized as large, as shown in Table IV.

TABLE IV. UNIVARIATE ANALYSIS OF VARIANCE

General Fatigue	Sum of squares	df	Mean of the squares	F	p =	η^2 =
Between groups	8.699	2	4.35	6.172	0.004	0.192
Within groups	36.646	52	0.705			
Total	45.345	54				
$\eta^2 > 0.14$ = large power						

The result of the ANOVA is confirmed by the H-test from Kruskal & Wallis [28]. Here too, only the omnibus test for General exhaustion is significant at $p = 0.002$. Therefore, both tests concluded that there are significant differences between the three groups overall. The subsequent post-hoc test shows, both in the ANOVA and the H-test, that the group using Zoom Avatars differs significantly from the other two learning environments.

The p-value is in the significant range between 0.006 and 0.017 for the comparisons with this environment, as can be seen in Table V. The effect size is also large in each case,

which means that it can now be said with certainty that the results of the Zoom Avatar learning environment differ significantly from the other two.

TABLE V. H-TEST KRUSKAL & WALLIS

General Fatigue							
Post Hoc Tests: Anova Group combinations	N 1	N 2	Mean 1	Mean 2	Mean difference	p =	Power d =
face-face-teaching (1) & Zoom Camera (2)	20	17	3.60	3.53	-0.07	0.965	0.080
face-face-teaching (1) & Zoom Avatar (3)	20	18	3.60	2.72	-0.88	0.006	1.066
Zoom Camera (2) & Zoom Avatar (3)	17	18	3.53	2.72	-0.81	0.017	0.992
d > 0.8 = large power							
General Fatigue							
Post Hoc: Kruskal & Wallis H-Test Group combinations	N 1	N 2	Average rank 1	Average rank 2	Average difference	p =	Power r =
face-face-teaching (1) & Zoom Camera (2)	20	17	33.05	32.97	-0.08	1.000	0.003
face-face-teaching (1) & Zoom Avatar (3)	20	18	33.05	17.69	-15.36	0.005	0.512
Zoom Camera (2) & Zoom Avatar (3)	17	18	32.97	17.69	-15.28	0.008	0.510
r > 0.5 = large power							

C. *Analysis of Zoom Fatigue causes*

As described in Section I, a distinction can be made between Zoom Fatigue symptoms and causes. A selection of 5 items from the ZEF Scale was used for the Zoom Fatigue symptoms and used in the questionnaire. As explained in Section III, 2 positive and 2 negative aspects can be selected for the Zoom Fatigue causes, which addresses the differences between virtual learning environments and classic video conferencing systems. Positive aspects are item 6, the opportunity to exchange ideas and network informally, and 7, an inspiring environment. Negative aspects include item 8, having to watch oneself, and 9, discomfort about others seeing one's own video image. Items 6 and 7 can be answered meaningfully in any type of virtual environment. It does not matter whether you have a video environment with a picture or a virtual environment with an Avatar. The situation is different for items 8 and 9, which require a video image and can, therefore, only be answered meaningfully if this virtual environment is available. Three different learning environments were used in the Trend seminar: face-to-face teaching, teaching via Zoom camera, and Zoom Avatar. Questions 6 and 9 are not meaningful for face-to-face teaching, so this learning environment is not included in the following analyses. Items 8 and 9 can only be answered meaningfully for the Zoom camera.

We will now check whether the two items 6 and 7 are related to 1 'I felt exhausted after a course'. To do this, these items are correlated with each other. As the number of cases is very low, both Pearson's r and Spearman's Rho are used as shown in Table VI. The feeling of exhaustion (item 1) is related to the opportunity for informal exchange and networking. A correlation coefficient of 0.5 or more is considered a strong correlation. The more the test subjects exchange ideas or network, the higher the perceived exhaustion. For 'Zoom camera', only the correlation with Pearson's r is significant, not with Spearman's Rho. The correlation of item 6 with item 1 is, therefore, doubtful. The situation is different for 'Zoom Avatar'. Here, both correlations are significant. For item 7, all correlations are not significant ($p > 0.05$). There is, therefore, no bivariate correlation between the two items.

TABLE VI. CORRELATION TO GENERAL FATIGUE

	Zoom Camera Pearson's r	Spearman's Rho	Zoom Avatar Pearson's r	Spearman's Rho
Item 6 I had the opportunity for informal exchange and networking in the virtual environment				
	0 581	0,530	0.671	0.642
p =	0 037	0,062	0.003	0.005
N =	13	13	17	17
Item 7 I found the virtual environment stimulating and inspiring				
	0 296	0.168	0.107	0.034
p =	0 351	0.602	0.673	0.894
N =	12	12	18	18

To not only measure the relationship between individual variables, as in the correlation analysis above, a multiple linear regression is also used. This allows us to measure the simultaneous influence of the two items 6 and 7 on the General feeling of exhaustion (item 1). The independent influences of the individual variables on the dependent variable are measured. Item 1 is used as the dependent variable; the independent variables are items 6 and 7. The correlation analysis has shown that the correlations for item 6 vary depending on the learning environment. Therefore, a dummy variable was introduced as a control variable. This controls for any possible influence of the two learning environments. The quality check for the multiple linear regression yielded the following results:

$N = 29$, $R = 0.795$, $R^2 = 0.632$, corrected $R^2 = 0.587$, the model is significant with $p = 0.000$. The R^2 of 0.632 means that 63.2% of the variance of variable F8.1 is explained by the three variables 6, 7 and the dummy variable. This means that the model has very good explanatory power. The results for the individual influences are shown in Table VII.

All three variables are significant with $p \leqslant 0.05$. The β values are of interest for interpretation as they indicate the strength of the influence of the individual variables on the dependent variable. As these values are standardized, they can be compared with each other. Variable 6 has the greatest influence on perceived exhaustion (β=0.814). The opportunity for informal exchange and networking in particular increases exhaustion.

TABLE VII. MULTIPLE LINEAR REGRESSION FOR ITEMS 6 AND 7 TO ITEM 1 GENERAL FATIGUE

Coefficients	Non-standardized coefficients B	Standard Deviation	Standardized coefficients β	T	p =
Constant	2.228	0.370		6.014	0.000
Item 6	0.692	0.144	0.814	4.803	0.000
Item 7	-0.323	0.137	-0.406	-2.354	0.027
Dummy	-0.828	0.235	-0.442	-3.528	0.002
Dependent Variable: Item 1 (General fatigue)					
Item 6: (Networking Opportunities)					
Item 7: (Stimulating Environment)					
Dummy: Zoom Avatar (Zoom Avatar = 1, Zoom Camera = 0)					

However, if the virtual environment is perceived as stimulating and inspiring (item 7, $\beta = -0.406$), this reduces the perceived exhaustion somewhat. However, the level of perceived exhaustion also depends on which virtual learning environment you are in. The 'Zoom Avatar' learning environment lowers General Fatigue compared to the 'Zoom Camera' learning environment with a strength of $\beta = -0.442$.

V. Discussion

This study focuses on the phenomenon of 'Zoom Fatigue', i.e. symptoms of exhaustion caused using online courses. Applied to academic courses, the question was whether different levels of Fatigue occur depending on the learning environment. It was expected that the two online units would differ from face-to-face teaching. However, this is not the case. Rather the Zoom camera environment differs from the other two learning environments. However, the overall level of Fatigue is not particularly high. The five items of Zoom Fatigue on the ZEF scale [Appendix] could be rated on a scale from 1 'strongly disagree' to 5 'strongly agree'. Even though the courses lasted more than 4 hours each day, the mean values of the items ranged between 2.00 and 3.29 for all three teaching environments. For the individual items, the highest mean for General Fatigue (item 1) was 3.6 for face-to-face teaching, followed by Zoom camera at 3.53. It was surprising that face-to-face teaching appeared to cause the most Fatigue, although it was closely followed by the Zoom Camera digital learning environment. Also striking was the significant difference between the Zoom Avatar learning environment and the other two groups. Based on the assumption that online events Generally lead to Fatigue, it was not expected that there would be significant differences between the different virtual environments. Obviously, the form of the virtual environment plays a crucial role, especially the use of cameras in classic videoconferencing systems. The use of Avatars instead of camera images in the still identical 'tile optics' significantly reduces General Fatigue.

The correlations show that there is a significant relationship between networks and perceived Fatigue. The more intense the perceived positive aspects of informal exchange and networking, the higher the perceived Fatigue. Interestingly, however, the multiple linear regression showed that perceived Fatigue decreases the more inspiring the virtual environment is perceived to be. In addition, Fatigue decreases slightly in the 'Zoom Avatar' learning environment.

VI. Conclusions and Future Work

As described in the previous sections, overall, a relatively low level of Fatigue was observed in the different learning environments. The group of test subjects may be even more resilient due to their relatively young age and higher ability to maintain concentration and receptivity in courses. It is also possible that the intrinsic motivation of master's students is Generally at a high level, as the choice of a Master's degree program is usually a conscious decision. Surprisingly, the value for General exhaustion was highest for the face-to-face program. This seems strange at first, as it was always assumed that longer online courses would lead to higher levels of exhaustion than face-to-face courses. In addition, the results of our own long-term study, which was also carried out as part of this program, show that students clearly prefer face-to-face teaching to online teaching because it allows for personal contact with other students and the tutor, promotes informal exchanges and the risk of distraction is lower [14]. So, it seems that the intensity and, therefore, the effort is higher in face-to-face courses, but at the same time, the students themselves want this intensity. In this context, one could speak of 'self-motivated Fatigue'. The results of the correlation analyses also show a surprising effect of increased Fatigue with good opportunities for informal exchange and networking. Again, this option, which is desired, seems to lead to increased Fatigue, as does face-to-face teaching. However, this Fatigue can be mitigated by an inspiring and stimulating environment. The pending analysis of the qualitative interviews conducted as part of this study may provide further information on these findings. Furthermore, analyses of virtual courses in 2D desktop (gather.town) and 3D desktop (framevr.io), which were also part of this study, are still pending. Also, the results of the qualitative interviews are not included so far, which could be interesting for the perception and identification of the Avatars. Furthermore, it could be interesting to ask about the distracting aspect of using Avatars and virtual environments, as well as the challenge on exams and the active participation of students acting as Avatars.

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