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WHAT WE NEED FOR ENCODING OF MEMORY AND EMOTIONAL RECONSOLIDATION

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SUMMARY

Background: *It is known that an interactive design and good participants' involvement strengthens the motivation to engage in learning processes. Previous research suggests attitude-behaviour consistency with relevance of subjective meaning and interest in learning. This observational study aims to measure the attitude of medical students.*

Methods: *The connotative meaning and perception of e-learning were explored. A semantic differential scale was given to all students (N=328) of a case-based blended-learning (CBBL) course, 296 medical students were included in this study.*

Results: *The online-survey completion rate was 100%. An exploratory principal components analysis with varimax rotation was performed. Five components could be extracted that explained 47.21% of the total variance. The five components are best described by the following adjectives taken from the item pool: "soft, emotional, playful", "clear and organised", "vigorous and serious", "vivid and outgoing", "economical and introverted". An additional qualitative analysis revealed relevant positive connotations ascribed to e-learning by the students: freedom in time and space for learning, interdisciplinary approach and communication, playfulness and clear, structured procedure.*

Conclusion: *Our study demonstrated that a specific set of aspects is essential for students to feel comfortable and affect-cognitively engaged to learn and gain the best exam grades.*

Key words: *semantic differential - e-learning - affect-cognitive involvement*

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INTRODUCTION

Obtaining knowledge and skills through studying or training is learning, whereas experience is acquired through carrying out an activity for a long time. Intrinsic motivation rests on the individual's awareness of the benefit by gaining new knowledge in contrast to extrinsic motivation, where the prospect of significant benefits or to eliminate disadvantages is the focus (Valois & Godin 1991). Targeting student motivation is key when aiming at long-term effects and encouraging students to make efforts to do well in their job and postgraduate curricula and carrier.

Depending on student's preferences and the task and knowledge field aspired, the e-Learning approach can provide an adequate training environment; various individual and social factors determine a student's hierarchy of needs and motivation. Advantages and disadvantages of e-Learning approaches have to be considered, it surely has its limitations (Ertl et al. 2020a, 2021). Factors beyond quality of teaching can determine learning success and student's expectation. In an e-learning environment, it is more difficult for instructors to distinguish various effects on learning success. Consequently, asking for feedback is crucial. The present survey aims at investigating users' feedback by applying a semantic differential. However, communication with students providing feedback also has been taking place via email by the professor.

For adequate curriculum development, adult learning principles and education theory have to be considered (Bentler & Lavoie 1972, Bortz & Schuster 2010, Ertl 2020a, Ertl et al. 2021). Merriam et al. (1987) and Knowles (Knowles & Malcolm S Knowles 1984) identified the difference in learning in three essential areas: learning process, the learner himself, and the context. Knowles postulated that self - directing is an essential aspect for the inner drive or intrinsic motivation for adults (Knowles & Malcolm S Knowles 1984). Regarding to Knowles the next theoretical approach is the social cognitive theory, shaped and developed by Bandura (Locke 1987, Swanwick 2010, Ertl 2020a). This theory's origin can be traced back to the family of social learning theories; Bandura combined the behaviorist and the cognitive approach, based on the assumption that our behavior results from a set of interdependent determinants: personal factors, behavioral factors, and environmental factors.

The present survey applies a rating scale that asks students about their associations concerning e-learning; thus, they are asked to decide how much of various traits or qualities e-learning has. By exploring the semantic denotations of e-learning factors influences on learning and memory are extracted.

METHODS

Description of e-learning course

For a thorough description of the e-learning course with the case-based blended learning approach, and the exact workflow see our previous work (Turk et al. 2015, 2019, Wadowski et al. 2015, Ertl et al. 2020a, 2021). In brief, e-learning strategies for students are provided as add on to the existing curriculum at the Medical University of Vienna and the University of Vienna (psychology, chemistry, biochemistry, biology, pharmacy, nutritional sciences). Case histories from different knowledge fields are created, solved and peer-reviewed by an interacting community of learners. Compatibility of medical e-learning cases is given with the CanMED ("CanMEDS Framework : The Royal College of Physicians and Surgeons of Canada," n.d.) framework, which defines physicians' roles (Medical Expert, Collaborator, Communicator, Health advocate, Manager, Scholar and Professional) and gives thematic groups of competencies (Frank et al. 2005). Furthermore, cases are structured on the basis of the Bloom's taxonomy criteria (Bloom et al. 1956). In a virtual environment, the students simulate a real-life scenario at a hospital ward and solve cases dependent on their knowledge and experience. The level of difficulty is given prior to entering the case history. Thus, mastering the successional levels is already proof for the learn success (for the case structure see Ertl et al. 2021). However, levels are also defined by specific tasks. Interaction within case histories happens whenever interdisciplinary consultations are called for by the peer-reviewing students.

Participants

This study includes all students that had registered for the voluntary e-learning platform at MUW between 2018 and 2020 and were active users in 2020 (N = 328). All students signed the informed consent. The study was approved by the data protection committee of the Medical University of Vienna. As students, but no patients were involved in the study, the ethics committee of the MUW was informed and the data protection committee approved. All included students answered the semantic differential. However, since the semantic differential questionnaire had been designed and evaluated for medical students only, participants with co-registration (n=32; 26 female and 6 male) were not included in the statistical analysis of the data. Thus, 296 questionnaires from medical students at the MUW were available for further analysis.

Instruments: Semantic differential

To measure medical students' attitude towards the offered e-learning course and new learning methods, Charles E. Osgood's semantic differential adapted by Voracek was used (Osgood 1952, Bentler & Lavoie 1972, Löffler-Stastka 2015, Turk et al. 2019). The 1951 first published tool can be used to explore the "connotative meaning" of objects, in a second step, the attitude towards the given objects can be derived (Wadowski et al. 2015). The semantic differential scale was given to all students (cross-sectional sample) attending the e-learning course at the end of the completion of the CBBL. For the online survey, all students rated the five-point scale with a set of adjectives. Twenty-five pairs of opposing adjectives were rated on a 5-point scale ranging from -2 (a left sided adjective is well matched) to +2 (a right sided adjective is well matched) (Thurstone 1931, Valois & Godin 1991).

Statistical Plan

Whether the scale used in the semantic differential is ordinal or interval (with a zero point in the middle) is still under debate. We followed the approach considering it as an interval scale with a neutral response as some kind of arbitrary zero point (Trochim 2007, Heise 2010). Thus, after an explorative, descriptive analysis of the data, pre-requisitions for performing an exploratory factor analysis were assessed. Kaiser-Meyer-Olkin (KMO) test is a measure of the proportion of variance among the data. As KMO returned a value of 0.744, exploratory factor analysis was possible (Norris & Lecavalier 2010, Cureton & D'Agostino 2013, Universität Zürich 2018) (see results). The Bartlett's test showed significant results (see results). Thus, an exploratory factor analysis with a varimax rotation was performed and Kaiser's eigenvalue-greater-than-one rule was applied for further analysis. Catell's scree plot, still one of the standard methods (Cattell 1966, Fabrigar et al. 1999, Larsen & Warne 2010, Ruscio & Roche 2012, Courtney 2013, Taherdoost et al. 2014, Warne & Larsen 2014) for determining the optimal number of factors the exploratory factor analysis should generate, was applied.

RESULTS

Study population and demographic data

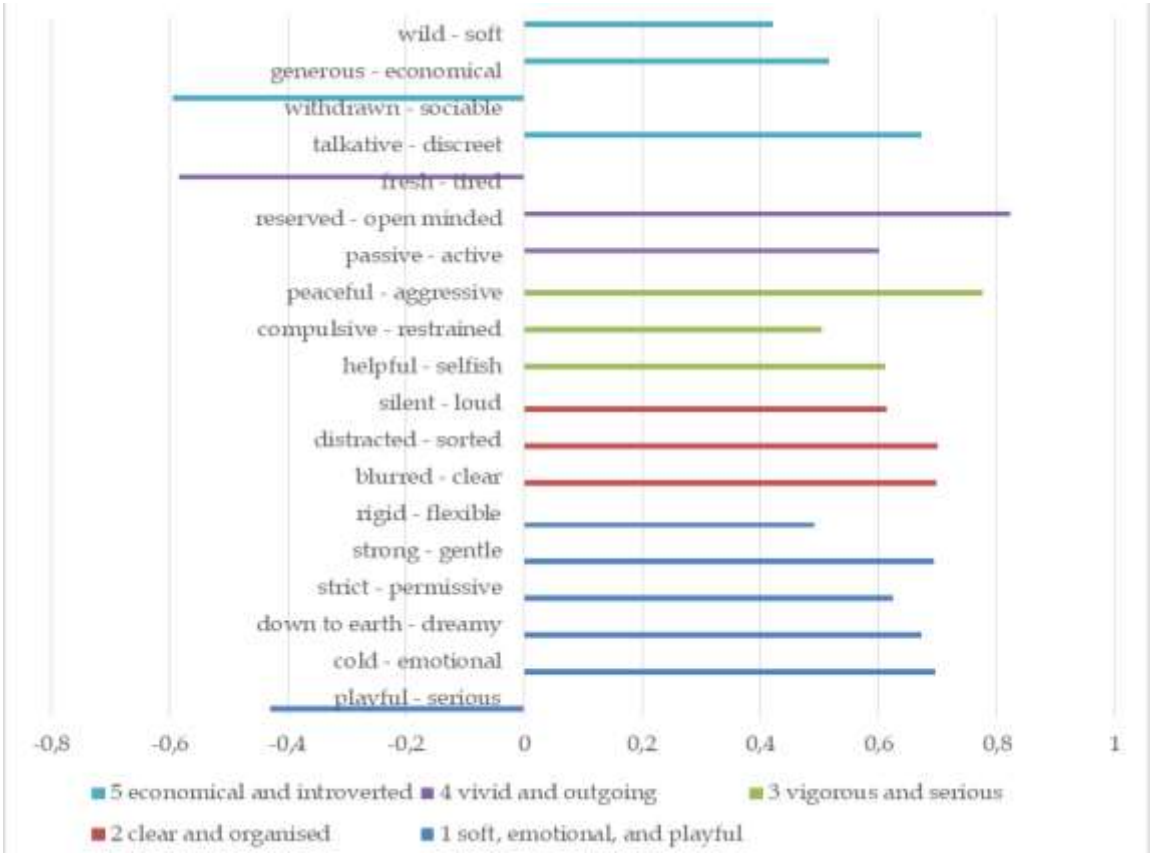
A total of 328 students participated in the elective course, 183 (55.8%) were female and 145 (44.2%) male students. Thirty-two (9.8%) students were co-registered at the University of Vienna. As mentioned above, only medical students were included in the analysis (n=296). Medical students were 157 (53%) females and 138 (47%) males. For one medical student the information regarding gender was not available. Medical students' mean age was 23.97±2.88.

At the time of the participation, two (0.6%) students attended the first, 19 (5.8%) students the second, 99 (30.2%) students the third, 85 (25.9%) students the fourth, 61 (18.6%) students the fifth, 30 (9.1%) students the last year.

Table 1. Loadings on the five components

	1 - soft, emotional playful	2 - clear and organised	3 - vigorous and serious	4 - vivid and outgoing	5 - economical, introverted
playful - serious	-0.430				
cold - emotional	0.697				
down to earth - dreamy	0.672				
strict - permissive	0.624				
strong - gentle	0.694				
rigid - flexible	0.492				
blurred - clear		0.699			
distracted - sorted		0.700			
silent - loud		0.614			
helpful - selfish			0.611		
compulsive - restrained			0.504		
peaceful - aggressive			0.776		
passive - active				0.602	
reserved - open minded				0.822	
fresh - tired				-0.584	
talkative - discreet					0.672
withdrawn - sociable					-0.595
generous - economical					0.516
wild - soft					0.421

Note: Table of loadings of 19 variables (pair of opposite adjectives) for each of the final five principal components that were found following the Scree plot. Thus, the table displays only those loadings that are considered the most important for each principal component.



Note: On the x-axis, the loadings of the relevant variables on the components are shown. The five components are highlighted in different colours. The higher the loading (either negative or positive), the better the variable (adjective pair) is represented through the analysis

Figure 1. Exploratory factor analysis: Item loadings on the five components

Year of cohort

The final year of the medical students was calculated using the information of the question on the current semester as well as the date of the interview. Thirteen students received their diploma in 2018, 41 students in 2019, 72 students in 2020, 106 students will receive the doctor's degree in 2021, 41 students in 2022, 15 students in 2023 and eight students in 2024.

Semantic Differential

Qualitative, descriptive analysis and check for the pre-requisitions of an exploratory factor analysis

An adapted version of the original semantic differential was used (Verhagen et al. 2015). Answers were first analysed in an explorative, descriptive sense (see Table 1 and Figure 1). An additional qualitative analysis of the relevant positive connotations ascribed to e-learning by the students was carried out and revealed that freedom in time and space for learning, interdisciplinary approach and communication, playfulness and clear, structured procedure were important aspects.

Exploratory factor analysis

Whether further statistical analysis can be performed was assessed prior to any further interpretation of the data (Bartholomew et al. 2008, Allen et al. 2013, Yong & Pearce 2013, Taherdoost et al. 2014).

Due to adequate results in Bartlett's Test of Sphericity $p<0.001$ (with an approx. Chi-Square of 1700.965) and Kaiser-Meyer-Olkin Measure of Sampling Adequacy KMO = 0.744, an exploratory principal components analysis with varimax rotation was performed (Ludwig-Mayerhofer 2004, Page et al. 2006, Cureton & D'Agostino 2013). Missing a priori hypothesis, exploratory factor analysis is an equivalent method to identify any structure of a Semantic Differential without a specific rating for each pair of words (Finch & West 1997).

Table 2. Exploratory Factor Analysis: Rotated component matrix converged in 14 iterations

	Component						
	1	2	3	4	5	6	7
soft - strong	-0.302	0.398	0.049	-0.221	0.006	0.262	0.262
cheerful - sad	-0.133	-0.183	0.391	0.022	-0.092	0.440	0.348
blurred - clear	-0.003	*0.699*	-0.067	0.182	0.067	-0.186	-0.121
strong - weak	0.383	-0.381	0.212	-0.080	0.160	0.365	0.293
generous - economical	0.148	0.239	-0.035	-0.160	*0.516*	0.078	0.356
passive - active	-0.037	0.300	-0.137	*0.602*	-0.070	-0.073	0.045
playful - serious	-0.430	0.303	0.007	0.348	0.052	0.203	0.238
reserved - open minded	0.044	0.099	-0.128	*0.822*	-0.036	0.015	-0.044
helpful - selfish	0.039	-0.065	*0.611*	-0.227	0.225	0.254	0.095
compulsive - restrained	-0.088	-0.012	*0.504*	0.020	0.374	-0.077	0.164
cold - emotional	*0.697*	0.186	-0.178	-0.008	-0.132	-0.010	-0.101
talkative - discreet	0.026	-0.077	0.328	-0.132	*0.672*	0.148	-0.069
peaceful - aggressive	-0.024	0.028	*0.776*	-0.132	-0.016	0.061	0.063
distracted - sorted	-0.126	*0.700*	-0.179	0.197	0.032	-0.048	0.055
down to earth - dreamy	*0.672*	-0.032	0.201	-0.081	0.084	-0.224	0.176
strict - permissive	*0.624*	-0.274	-0.023	0.039	0.369	-0.030	-0.118
withdrawn - sociable	0.399	0.170	-0.070	0.107	*-0.595*	-0.010	0.036
strong - gentle	*0.694*	-0.243	-0.080	0.048	-0.178	0.149	0.046
amused - upset	-0.025	-0.030	0.024	-0.149	0.216	*0.758*	0.091
wild - soft	0.225	0.090	-0.395	0.236	0.421	0.255	-0.044
rigid - flexible	0.492	0.098	-0.105	0.198	0.045	-0.069	-0.487
silent - loud	0.061	*0.614*	0.219	0.037	-0.235	0.269	-0.009
fresh - tired	-0.031	0.050	0.080	*-0.584*	0.195	0.196	0.379
submissive - imperious	-0.307	0.360	0.165	0.071	-0.058	0.471	-0.277
healthy - sick	0.017	-0.008	0.157	-0.012	0.014	0.019	*0.747*

Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization: a. Rotation converged in 14 iterations. *Note*: In a first step, following Kaiser's eigenvalue-greater-than-one rule, all components with a greater "eigenvalue" than one were used. Estimates of the correlations between each of the variables and the estimated components are given. The table highlights (with *italic*) those loadings that are considered the most important for each principal component (> 0.5 or < -0.5 loading on the component). However, following the Scree Plot, only five components were finally extracted.

Table 3. Semantic differential: Communalities

	Initial	Extraction
soft - strong	1.000	0.438
cheerful - sad	1.000	0.528
blurred - clear	1.000	0.579
strong - weak	1.000	0.589
generous - economical	1.000	0.505
passive - active	1.000	0.484
playful - serious	1.000	0.499
reserved - open minded	1.000	0.708
helpful - selfish	1.000	0.554
compulsive - restrained	1.000	0.435
cold - emotional	1.000	0.580
talkative - discreet	1.000	0.609
peaceful - aggressive	1.000	0.629
distracted - sorted	1.000	0.584
down to earth - dreamy	1.000	0.588
strict - permissive	1.000	0.617
withdrawn - sociable	1.000	0.560
strong - gentle	1.000	0.606
amused - upset	1.000	0.655
wild - soft	1.000	0.515
rigid - flexible	1.000	0.546
silent - loud	1.000	0.558
fresh - tired	1.000	0.572
submissive – imperious	1.000	0.558
healthy – sick	1.000	0.584

Note: Extraction Method: Principal Component Analysis. Principal component analysis revealed seven factors with eigenvalues greater than 1. The communalities are presented in this table. Communalities explain the amount of variance (within each pair) explained by the factors

Thus, an exploratory principal components analysis with a varimax rotation and maximum of 25 iterations of convergence in a sample of 296 students was conducted and produced seven components (see supplementary information Table 2 and 3: the rotated component matrix and the total amount of variance on original variables).

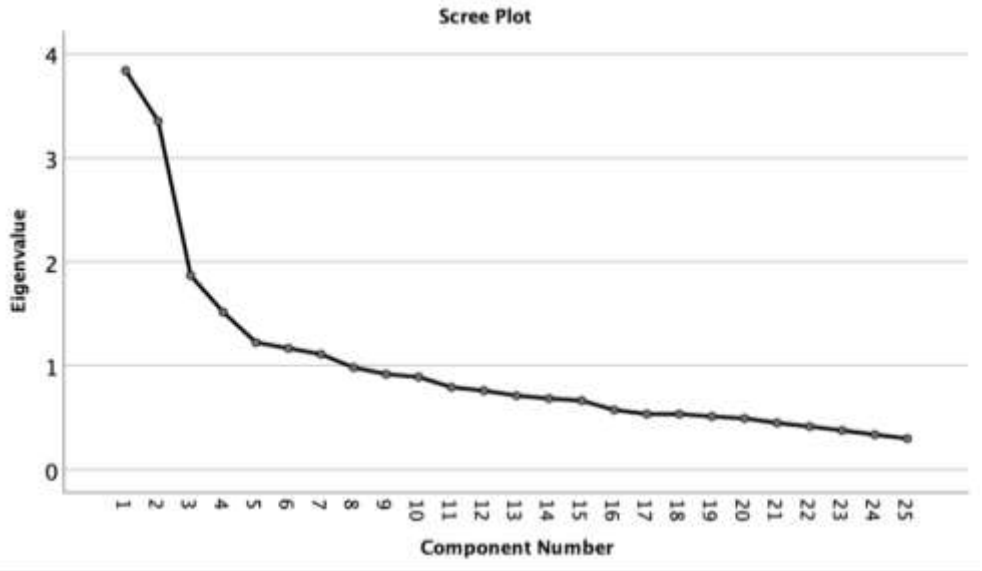
Regarding Kaiser's Eigenvalue-greater-than-one rule, all components with a greater "Eigenvalue" than one can be used. However, this model would violate the scree plot introduced by Catell (1966). It has to be stressed out that Courtney claimed Catell's scree plot in 2013 as too strict (Courtney 2013). Nevertheless, using the scree plot is still the standard and widely accepted; therefore, only five components were used (Fabrigar et al. 1999, Larsen & Warne 2010, Ruscio & Roche 2012, Courtney 2013, Taherdoost et al. 2014, Warne & Larsen 2014) (see supplementary information Figure 2).

The results explained 47.21% (rotation sum of squared loading) of the total variance. The first component explained 15.36% of the initial "Eigenvalues", the second component 13.42%, the third 7.47%, the fourth 6.06% and the fifth component 4.90% (see supplementary information Table 4). The loadings on the five components are characterized in Table 1 and Figure 1.

Table 4. Exploratory factor analysis: Variance explained per component

Component	Initial Eigenvalues	Cumulative%
1	15.364%	15.364%
2	13.418%	28.782%
3	7.471%	36.252%
4	6.060%	42.312%
5	4.895%	47.207%

Note: The first five components have an eigenvalue greater than one and together they explain 47.21 % of the variance



Note: The principal components to keep were selected based on the scree plot. The cutting-off point shows that component 1-5 (all with eigenvalues > 1) are enough to describe the data.

Figure 2. Scree Plot

Factors with a loading value of more than ± 0.4 were analysed and clustered to a group of two or three adjectives that describe each component. However, the elements strong/soft and compulsive/restrained were the least well represented by the analysis (see Figure 1 and Table 1). The extracted components were "soft, emotional, playful" for the first component, "clear and organised" for the second, "vigorous and serious" for the third, "vivid and outgoing" for the fourth and "economical and introverted" for the fifth component (Yong & Pearce 2013). Thus, ratings of students regarding their experience with e-learning clustered around five themes: „learning through play, getting involved", „effective learning: structure and attention", „social interactivity", „hidden costs" (see Table 4 for the variance explained per component).

DISCUSSION

Each component was first described by a group of adjectives taken from the variable-pool based on the factor loadings of the variables. The interpretation of the five factors extracted from the PCA, is based on the qualitative analysis of the evaluation of the e-learning course. As the e-learning was voluntary, and the platform is in continuous evaluation, the answers of the participants surely will contribute to further improvement of the platform. This is even more so as completers of this e-learning course all managed to pass the obligatory MUW exams (Ertl et al. 2021).

Learning through play, getting involved

The first factor can be described as soft, emotional, and playful; this can be traced back to the course's elective aspect and the fact that sections with multiple questions can be repeated until the question is marked as positive. Negative results are not stored.

Researchers and educators have been trying to integrate play and learning, as playfulness has been suggested to motivate and to promote performance (Heimann & Roepstorff 2018, Letourneau & Sobel 2020). In a playfulness state, exploratory engagement is more likely-sometimes with surprising results. However, playfulness seems to depend less on the activity but on the character traits of the learners – the disposition to play (Lieberman 1966). To describe playfulness, traits have been proposed (humour, spontaneity; see (Proyer 2012)). Proyer's study showed that playful adults are more likely to also be extraverted, agreeable. However, also in playfulness, variance seems to exist with traits like ingenuity and spontaneity being more likely associated with creativity. Intrinsic motivation, involvement with tasks and a positive work outcome are more likely associated with playfulness (Glynn 1992). Overall, the feedback that the e-learning tool is connoted with playfulness is a very positive finding and matches the aspiration.

Positive influences of emotions on memory and long-term learning are known; emotional significance matters when encoding memory (Phelps 2004, Tyng et al. 2017). Thus, considering the connotation "emotional" evoked by the term "e-learning", this also fits the approach; creating an emotional experience when studying was part of the core concept. Connotations of "soft" are more difficult to conceptualize. However, being soft in the context of learning together with being playful and emotional about the experience could indicate the experience of getting involved, being compassionate about something. Also, the fashion feedback is given in the e-learning platform, is designed to be constructive, collaborative and personalized.

Effective learning: structure and attention

The second factor was summarised as clear and organised. The timetable and the clear structure of the course might explain this attribution. However, to use e-learning efficiently, self-discipline is required- and outcome depends on ambition and on flexibility to adapt to task structure.

Radulescu et al. (2019) have outlined an explanation for the existing link between structure in the environment and its influences on learning by proposing selective attention biases towards relevant environmental stimuli based on acquired, structured knowledge. Thus, learning about a specific stimulus might be facilitated when attending to this stimulus (selective attention) and is enhanced by the features of the actual environment (Mackintosh 1975, Niv et al. 2015).

Social interactivity: The good enough facilitating environment

The third and the fourth factors presented just the opposite. For some students the elective course is vigorous and serious and for other students vivid and outgoing. This may not be obvious at first, but cross-loadings in the results underlined the data's quality (Fabrigar et al. 1999, Norris & Lecavalier 2010).

Psychoanalytical object relations theory (Klein 1960, Bowlby 1973) states that expectations on interactions with others arise from early experiences with more or less consistent, sensitive and responsive caregivers. Thus, social and emotional development starts with proximity seeking (in childhood) and results in more or less integrated self- and other models that influence on attachment patterns (secure, avoidant, disorganized), emotion perception and regulation abilities, and personality development. A community of learners in an e-learning platform might acquire the features of an attachment figure. As it is continuously available and accessible and it furthermore provides stimulation (social interactions, content), and constructive feedback, it also provides holding.

Furthermore, interaction with peers, teachers and instructors depends on the learner's initiative. Depending on prior knowledge and skills, given tasks might require asking for a statement; this might be less straightforward. However, leaving questions open and concepts unclarified might be rather unsatisfying and result in

resignation. Thus, how to provide and encourage interactivity in e-learning is one of the most important aspects to work on. Meta-Analysis has shown the potential of peer feedback in developing professional behaviour in team-based learning (Lerchenfeldt et al. 2019).

To some extent, the feeling that a concept evokes, might depend on the personality of the participant. As the e-learning course is a voluntary learning opportunity, users that engage with this tool are supposed to feel attracted by its features. Possibly, students with higher conscientiousness (achievement-oriented, systematic) were attracted by the possibility of this additional training-opportunity (factor three). However, also for students with openness to new ideas, this new possibility to socially engage in a virtual environment (combination of personality traits: openness/curiosity and extraversion; factor four) might be interesting.

Development of e-learning: hidden costs and necessary diligence in planning

The final factor referred to the resources and costs that are necessary. On this account, the course was described as economical and introverted. However, the development process takes time and requires a thorough cost calculation, technical expertise, tools for content development and maintenance. Additionally, implementation of user-feedback (usability) often requires revision. Updating content and tools might require extra support staff.

Development, delivery and implementation of e-learning services in health professional education appear to be rather cost-efficient in general at least when comparing with face-to-face instruction (Meinert et al. 2021). However, as Meinert et al. outlined methodology for cost analysis of different studies assessing costs of e-learning varies; comparability is lacking and analysis whether investments are justified is difficult.

Equality of opportunity in education is more likely when services are made accessible for every student, independent of his/her socio-economic and cultural background. E-learning might be one cost-efficient way to reduce obstacles to education (including access to learning facilities, flexible time-schedule).

Didactic methods in general have shifted to a more discursive teaching, thus maybe favouring extroverts. As active participation and communication with team-members surely is required especially in clinical contexts, there is a necessity to train these abilities (Lee 2017, Noureddine & Medina 2018). However, "silent" skills are not to be neglected (observation, reasoning processes, listening skills, learning how to learn Lee 2017). Environmental influences have been shown to affect introverts differently than extroverts and preferred stimulation levels vary (Geen 1984, Valois & Godin 1991). During the coronavirus disease (COVID)-19 pandemic introverted individuals were more likely to report loneliness, anxiety and depression but not cognitive impairment (Wei 2020). Depression is rather high in medical students; Wallace et al. found that it increases with student's transition from preclinical to clinical training (Tuovinen et al. 2020). Student's personalities should be considered when teaching, and introverted students should be encouraged to engage in peer training as a preparation for teamwork (Noureddine & Medina 2018, Tuovinen et al. 2020).

Case-based e-learning provides a successful tool to control students' learning process and promote students' satisfaction (Chéron et al. 2016).

Moreover, especially in times of social distancing, the value of burnout prevention through e-learning processes in medical students should be emphasized (Pathipati & Cassel 2018).

Improvement of the quality of e-learning services will establish on the student's feedback, on this survey and further surveys on learners' satisfaction are warranted. Moreover, comprehensive analysis of the semantic differential and the exploratory factor analysis to identify and process complex interrelations and interactions will be considered in further studies.

Limitations

In general, limitations of e-learning can be found in two areas: any personal issues concerning online courses and tools and technological limitations (Wong 2007).

Technical aspects

Any necessary resources to access and use the e-learning environment are technological limitations. Both participants and educators need a compatible device and a reliable and fast network connection (Kathawala etal. 2002, Mahanta & Ahmed 2012). For this reason, the library of the Medical University of Vienna offers computers to all students that can be used free of charge during opening hours (https://ub.meduniwien.ac.at/). Due to an increased demand for design and usability nowadays, considerable efforts and costs for the development and maintenance are needed (Svensson 2004, Ivergård & Hunt 2005). Lacking these resources is also a technological limitation (Steen 2008). In contrast to traditional teaching and lectures on the campus, e-learning requires preparation and scheduling. This can vary, depending on existing knowledge and experience on using e-learning tools. Without any guidance, students tend to get lost in online systems as Dearnley et al. (2003) published.

Dropouts

For e-learning environments, high dropout rates have been found. Around 40-50% of the students enrolled for the elective course quit after a few weeks. This very high rate matches existing evidence in the literature and was already described by Abouchedid et al. (2004). In their study, no explanation was found (Tresman 2002). Students who dropped out were contacted via email, thus reasons for the cessation are known to the study coordinators. The complete e-learning environment at the Medical University of Vienna and University of Vienna is so far only provided in German. Thus, part of the

dropouts in our survey were due to language barriers. Other common problems reported by students were issues with time management (missed deadlines).

One could argue that also usability issues (Ardito et al. 2004) should be investigated, and analysed further (complexity of the interface, ease and mode of interaction, ability to catch the learner's interest, appointment/due dates reminding software etc.).

Considering our analysis of subjective meaning of e-learning to the participants, one could argue that by increasing social interactivity of the tool already when entering the platform could facilitate the feeling of becoming part of the e-learning community. This is also crucial as learning and memory depend on affective involvement - more readily stimulated by social stimuli.

User Feedback

The high percentage of participants providing feedback and valid contributions to the current study could be interpreted as interest in and commitment to the development of the platform.

The study was based on self-reported data, presenting a potential limitation. For this reason, multiple state-of-the-art in-depth analyses of the data, such as sampling inspection and plausibility checks, were performed (Ertl 2020b, Lipsitch et al. 2020).

It has to be stressed out that through the participation of highly motivated students in this elective course the average grades of the cohort improved, which was also reported previously (Turk et al. 2015).

Page visits during the COVID – 19 pandemic

The worldwide pandemic, caused by COVID-19 forced institutions and universities to close their facilities, any face-to-face lectures were therefore no longer an option (Ardito et al. 2004). The result was a great demand for online courses. Many schools and universities established e-learning (https://www.univie.ac.at/en/about-us/further-information/coronavirus/; https://www. meduniwien.ac.at/web/en/about-us/news/detailsite/2020/news-im-maerz/meduni-wien-stellt-studienbetrieb-auf-home-learning-um/). Up to 1000 students visited our platform simultaneously, and 7000 postings were made only in one day.

CONCLUSION

We emphasise that a case-based e-learning tool is an excellent approach for skills and communication training (Koh et al. 2008, Berkhof et al. 2011, Gartmeier et al. 2015) and an ideal setting for exam training appropriate to students' grades (Turk et al. 2015, 2019). Case-based learning could be a promising approach to enhance the cooperation- and communication-skills of medical students regarding the fact that students train thinking, arguing and deciding as doctors in the clinical environment (Antonoff et al. 2016, Grangeia et al. 2016, Luo et al. 2017, Ertl 2018, Turk et al. 2019, Wadowski et al. 2019, Ertl 2019, 2020a, Ertl et al. 2020a, 2020b, 2021). Diagnostic reasoning can be seen as case-based problem-solving (Mandin et al. 1995, 1997, Kassirer 2010). According to Kopp et al. (2008), learning with "worked examples" or real-world data show a higher outcome than teaching abstract information. This can be traced back to a different level of cognitive load (Kopp et al. 2008, Kiesewetter et al. 2013, Ertl 2020b).

Verified feedback entices students on working significantly longer with the offered learning environment. Moreover, with given clinical examples, which comprise possible sources of errors, diagnostic knowledge can be acquired in combination with elaborated feedback (Ertl 2020a). Therefore, the pedagogical aspect of errors and the feedback on them should be considered. It can be expected that specific diagnostic conclusion can induce deep conceptual understanding (Kopp et al. 2008, Ertl et al. 2021).

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Sebastian Ertl: conducted the study and wrote the first draft.

Dagmar Steinmair: edited and revised.

Patricia Wadowski: helped with rating and categorizing.

Henriette Loeffler-Stastka: conceived and revised the study.

References

1. *Abouchedid K & Eid GM: E-learning challenges in the Arab world: Revelations from a case study profile. Quality Assurance in Education 2004; 12:15–27*
2. *Allen DN, Thaler NS, Cross CL & Mayfield J: Classification of traumatic brain injury severity: A neuropsychological approach. In Aldenderfer Allen Armitage (ed.): Cluster Analysis in Neuropsychological Research: Recent Applications 2013, 95–123*
3. *Antonoff MB, Verrier ED, Allen MS, Aloia L, Baker C, Fann JI, Iannettoni MD, Yang SC & Vaporciyan AA: Impact of Moodle-Based Online Curriculum on Thoracic Surgery In-Training Examination Scores. Annals of Thoracic Surgery 2016; 102:1381–6*
4. *Ardito C, De Marsico M, Lanzilotti R, Levialdi S, Roselli T, Rossano V & Tersigni M: Usability of e-learning tools. Proceedings of the working conference on Advanced visual interfaces 2004; 80–4*
5. *Bartholomew DJ, Steele F, Galbraith J & Moustaki I: Analysis of multivariate social science data, second edition. Analysis of Multivariate Social Science Data, Second Edition 2008; 29:1–363*
6. *Bentler PM & Lavoie AL: A nonverbal semantic differential. Journal of Verbal Learning and Verbal Behavior 1972; 11:491–6*
7. *Berkhof M, van Rijssen HJ, Schellart AJM, Anema JR & van der Beek AJ: Effective training strategies for teaching communication skills to physicians: An overview of systematic reviews. Patient Education and Counseling, 2011*

8. *Bloom BS, Engelhart MD, Furst EJ, Hill WH & Krathwohl DR: Taxonomy of educational objetives: the classification of educational goals: Handbook I: cognitive domain. D. Mckay, New York, 1956*
9. *Bortz J & Schuster C: Statistik für Human- und Sozialwissenschaftler. Springer, Berlin Heidelberg, 2010*
10. *Bowlby J. Attachment and loss: Separation, anxiety and anger. In Bowlby (ed): Attachment and loss: Volume II: Separation, anxiety and anger. The Hogarth Press, London, 1973*
11. *CanMEDS Framework: The Royal College of Physicians and Surgeons of Canada. (n.d.)*
12. *Cattell RB: The Scree Test For The Number Of Factors. Multivariate Behavioral Research 1966; 1:245–76*
13. *Chéron M, Ademi M, Kraft F & Löffler-Stastka H: Case-based learning and multiple choice questioning methods favored by students. BMC Medical Education 2016; 16:1-7*
14. *Courtney MGR: Determining the number of factors to retain in EFA: Using the SPSS R-Menu v2.0 to make more judicious estimations. Practical Assessment, Research and Evaluation 2013; 18: 1–14*
15. *Cureton EE & D'Agostino RB: Factor Analysis. Psychology Press, 2013*
16. *Dearnley C: Student support in open learning: Sustaining the process. International Review of Research in Open and Distance Learning. Athabasca University Press, 2003*
17. *Ertl S: Diploma thesis: Impact of e-learning on learning efficiency and interdisciplinary collaboration. Medical University of Vienna, 2020a*
18. *Ertl S & Löffler-Stastka H: Vienna tracking students in 25.000 exam results. AMEE Conference presetation, 2018*
19. *Ertl S, Stastka L & Löffler-Stastka H: Strukturiertes fallorientiertes Lernen. Psychopraxis. Neuropraxis 2020a; 23:240–5*
20. *Ertl S, Steinmair D & Löffler-Stastka H: Encouraging communication and cooperation in e-learning: Solving and creating new interdisciplinary case histories. GMS Journal for Medical Education 2021; 38: Doc62*
21. *Ertl S, Löffler-Stastka H: Case Based Blended Learning (CBBL) – a strategy to foster the transfer of declarative to procedural knowledge or more? AMEE Conference Presentation, 2019*
22. *Fabrigar LR, MacCallum RC, Wegener DT & Strahan EJ: Evaluating the use of exploratory factor analysis in psychological research. Psychological Methods, 1999*
23. *Finch JF & West SG: The investigation of personality structure: Statistical models. Journal of Research in Personality 1997; 31:439–85*
24. *Frank JR, Jabbour M, Fréchette D, Marks M, Valk N & Bourgeois G: The CanMEDS 2005 Physician Competency Framework. Better standards. Better physicians. Better care. Framework 2005; 1–40*
25. *Gartmeier M, Bauer J, Fischer MR, Hoppe-Seyler T, Karsten G, Kiessling C, Möller GE, Wiesbeck A & Prenzel M: Fostering professional communication skills of future physicians and teachers: effects of e-learning with video cases and role-play. Instructional Science 2015; 43:443–62*
26. *Geen RG: Preferred stimulation levels in introverts and extroverts: Effects on arousal and performance. Journal of Personality and Social Psychology 1984; 46:1303–12*
27. *Glynn MA: the Adult Playfulness Scale: an Initial Assessment. Psychological Reports 1992; 71:83*
28. *Grangeia T de AG, de Jorge B, Franci D, Santos TM, Setubal MSV, Schweller M & de Carvalho-Filho MA: Cognitive load and self-determination theories applied to e-learning: impact on students' participation and academic performance. PloS one 2016; 11*
29. *Heimann KS & Roepstorff A: How playfulness motivates - putative looping effects of autonomy and surprise revealed by micro-phenomenological investigations. Frontiers in Psychology 2018; 9:1704*
30. *Heise DR: Surveying Cultures: Discovering Shared Conceptions and Sentiments. Surveying Cultures: Discovering Shared Conceptions and Sentiments. John Wiley & Sons, 2010*
31. *Ivergård T & Hunt B: Towards a learning networked organisation: Human capital, compatibility and usability in e-learning systems. Applied Ergonomics 2005; 36:157–64*
32. *Kassirer JP: Teaching clinical reasoning: Case-based and coached. Academic Medicine 2010; 85: 1118–24*
33. *Kathawala Y, Abdou K & Elmuti DS: The global MBA: A comparative assessment for its future. Journal of European Industrial Training 2002; 26:14–23*
34. *Kiesewetter J, Ebersbach R, Görlitz A, Holzer M, Fischer MR & Schmidmaier R: Cognitive Problem Solving Patterns of Medical Students Correlate with Success in Diagnostic Case Solutions. PLoS ONE 2013; 8*
35. *Klein M: Über das Seelenleben des Kleinkindes: Einige theoretische Betrachtungen. Psyche 1960; 14:284–316*
36. *Knowles MS & Malcolm S Knowles: Andragogy in action. Journal of Food Science 1984*
37. *Koh GCH, Khoo HE, Wong ML & Koh D: The effects of problem-based learning during medical school on physician competency: A systematic review. Cmaj 2008; 178:34–41*
38. *Kopp V, Stark R & Fischer MR: Fostering diagnostic knowledge through computer-supported, case-based worked examples: Effects of erroneous examples and feedback. Medical Education 2008; 42:823–9*
39. *Larsen R & Warne RT: Estimating confidence intervals for eigenvalues in exploratory factor analysis. Behavior Research Methods 2010; 42:871–6*
40. *Lee SS: Has medical education killed "silence"? Medical Teacher 2017; 39: 444–5*
41. *Lerchenfeldt S, Mi M & Eng M: The utilization of peer feedback during collaborative learning in undergraduate medical education: A systematic review. BMC Medical Education 2019; 19:1–10*
42. *Letourneau SM & Sobel DM: Children's descriptions of playing and learning as related processes. PLoS ONE 2020; 15:e0230588*
43. *Lieberman JN: Playfulness: an attempt to conceptualize a quality of play and of the player. Psychological reports 1966; 19:1278*
44. *Lipsitch M, Swerdlow DL & Finelli L: Defining the Epidemiology of Covid-19 - Studies Needed. New England Journal of Medicine 2020; 382:1194–6*
45. *Locke EA: Social Foundations of Thought and Action: A Social-Cognitive View. Academy of Management Review 1987; 12:169–71*
46. *Löffler-Stastka H: Do our medical students even want e-learning? A user rated evaluation of case based e-learning in undergraduate medical education at the medical university of Vienna. Advances in Social Sciences Research Journal 2015; 2:156–61*
47. *Ludwig-Mayerhofer W: ILMES-Internet-Lexikon der Methoden der empirischen Sozialforschung, 2004*
48. *Luo L, Cheng X, Wang S, Zhang J, Zhu W, Yang J & Liu P: Blended learning with Moodle in medical statistics: An assessment of knowledge, attitudes and practices relating to e-learning. BMC Medical Education 2017; 17*

49. *Mackintosh NJ: A theory of attention: Variations in the associability of stimuli with reinforcement. Psychological Review 1975; 82:276–98*
50. *Mahanta D & Ahmed M: E-Learning Objectives , Methodologies, Tools and its Limitation. International Journal of Innovative Technology and Exploring Engineering (Vol. 2), 2012*
51. *Mandin H, Harasym P, Eagle C & Watanabe M: Developing a "clinical presentation" curriculum at the University of Calgary. Academic Medicine 1995; 70:186–93*
52. *Mandin H, Jones A, Woloschuk W & Harasym P: Helping students learn to think like experts when solving clinical problems. Academic Medicine 1997; 72:173–9*
53. *Meinert E, Eerens J, Banks C, Maloney S, Rivers G, Ilic D, Walsh K, Majeed A & Car J: Exploring the Cost of eLearning in Health Professions Education: Scoping Review. JMIR Medical Education 2021; 7:e13681*
54. *Merriam SB: Adult Learning and Theory Building: A Review. Adult Education Quarterly 1987; 37:187–98*
55. *Niv Y, Daniel R, Geana A, Gershman SJ, Leong YC, Radulescu A & Wilson RC: Reinforcement Learning in Multidimensional Environments Relies on Attention Mechanisms. Journal of Neuroscience 2015; 35:8145–57*
56. *Norris M & Lecavalier L: Evaluating the Use of Exploratory Factor Analysis in Developmental Disability Psychological Research. Journal of Autism and Developmental Disorders 2010; 40:8–20*
57. *Noureddine L & Medina J: Learning to Break the Shell. Academic Medicine 2018; 93:822*
58. *Osgood CE: The nature and measurement of meaning. Psychological Bulletin 1952; 49:197–237*
59. *Bartlett T, Levene T: Bartlett's Test, 2006*
60. *Pathipati AS & Cassel CK: Addressing Student Burnout. Academic Medicine 2018; 93:1607–9*
61. *Phelps EA: Human emotion and memory: interactions of the amygdala and hippocampal complex. Current Opinion in Neurobiology 2004; 14:198–202*
62. *Proyer RT: Examining playfulness in adults: Testing its correlates with personality, positive psychological functioning, goal aspirations, and multi-methodically assessed ingenuity. Psychological Test and Assessment Modeling 2012; 54:103–27*
63. *Radulescu A, Niv Y & Ballard I: Holistic Reinforcement Learning: The Role of Structure and Attention. Trends in Cognitive Sciences 2019; 23:278–92*
64. *Ruscio J & Roche B: Determining the number of factors to retain in an exploratory factor analysis using comparison data of known factorial structure. Psychological Assessment 2012; 24:282–92*
65. *Steen H: Effective eLearning design. Journal of Online Learning and Teaching 2008; 4*
66. *Svensson L: Challenges for work-integrated e-learning: The case of the Swedish Academy of County Administrations. Journal of Workplace Learning 2004; 16:492–502*
67. *Swanwick T: Understanding Medical Education: Evidence, Theory and Practice. Wiley-Blackwell, Oxford UK, 2010*
68. *Taherdoost H, Sahibuddin S & Jalaliyoon N: Exploratory factor analysis: Concepts and theory. 2nd International Conference on Mathematical, Computational and Statistical Sciences, WSEAS, 2014*
69. *Thurstone LL: The measurement of social attitudes. Journal of Abnormal and Social Psychology 1931; 26:249–69*
70. *Tresman S: Towards a Strategy for Improved Student Retention in Programmes of Open, Distance Education: A Case Study From the Open University UK. The International Review of Research in Open and Distributed Learning 2002; 3*
71. *Trochim WMK: Research methods knowledge base: Likert scaling. Encyclopedia of Measurement and Statistics, 2007*
72. *Tuovinen S, Tang X & Salmela-Aro K: Introversion and Social Engagement: Scale Validation, Their Interaction, and Positive Association With Self-Esteem. Frontiers in Psychology 2020; 11*
73. *Turk B, Ertl S, Wong G, Wadowski PP & Löffler-Stastka H: Does case-based blended-learning expedite the transfer of declarative knowledge to procedural knowledge in practice? BMC Medical Education 2019; 19: 447*
74. *Turk BR, Krexner R, Otto F, Wrba T & Löffler-Stastka H: Not The Ghost in The Machine: Transforming Patient Data into E-Learning Cases Within A Case-Based Blended Learning Framework For Medical Education. Procedia - Social and Behavioral Sciences 2015; 186:713–25*
75. *Tyng CM, Amin HU, Saad MNM & Malik AS: The Influences of Emotion on Learning and Memory. Frontiers in Psychology 2017; 8*
76. *Universität Zürich: UZH - Methodenberatung - Faktoranalyse, 2018*
77. *Valois P & Godin G: The importance of selecting appropriate adjective pairs for measuring attitude based on the semantic differential method. Quality and Quantity 1991; 25:57–68*
78. *Verhagen T, van den Hooff B & Meents S: Toward a better use of the semantic differential in IS research: An integrative framework of suggested action. Journal of the Association for Information Systems 2015; 16:108–43*
79. *Wadowski PP, Steinlechner B, Schiferer A & Löffler-Stastka H: From clinical reasoning to effective clinical decision making - new training methods. Frontiers in Psychology 2015; 6:473*
80. *Wadowski PP, Litschauer B, Seitz T, Ertl S & Löffler-Stastka H: Case-based blended eLearning scenarios - adequate for competence development or more? Neuropsychiatrie 2019; 33:207–11*
81. *Warne RT & Larsen R: Evaluating a proposed modification of the Guttman rule for determining the number of factors in an exploratory factor analysis. Psychological Test and Assessment Modeling 2014; 56:104–23*
82. *Wei M: Social Distancing and Lockdown – An Introvert's Paradise? An Empirical Investigation on the Association Between Introversion and the Psychological Impact of COVID19-Related Circumstantial Changes. Frontiers in Psychology 2020; 11:2440*
83. *Wong D: A critical literature review on e-learning limitations. Journal for the Advancement of Science & Arts 2007*
84. *Yong AG & Pearce S: A Beginner's Guide to Factor Analysis: Focusing on Exploratory Factor Analysis. Tutorials in Quantitative Methods for Psychology 2013; 9:79–94*

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