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Socially-Engaged Distance Design Collaboration

A Study on the Effects of Digital Collaboration Over Design-Based Creativity

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Applied design education was required to replicate the socially constructivist structure through digital tools due to Covid-19 Pandemic. However, the effects of distant design education on the students' learning experience are not stated yet. For this reason, this study aims to discuss what are the affective learning outcomes, creative and design self-efficacy and visual literacy levels of design students. Within this framework, the effects of distance education in the scope of introduction to industrial design course was indicated and discussed through reflections and self-evaluation surveys. The study was held with 26 first year industrial design students in the fall semester of the 2020-2021 academic year. Digital collaboration tools on the students' perspective provide a ground for socialization and group work, simultaneously supporting distant collaboration in the educational perspective. This interaction comes forward as motivational support for students, more importantly, leads to an increased level of self-awareness in various layers of learning.

Keywords: distance learning; design education; design collaboration; self-efficacy; visual literacy

Introduction

Applied design education includes a social constructivist approach. However, the only obligation to use distance learning, which comes with the pandemic, has forced this social interaction to transform. The different digital tools used in this distance education are designed to replicate the classroom environment, but the contribution of these tools to the student's learning process is not yet completely known.

The affective learning outcomes of design education focus on improving the learners' creative and design skills and also their visual literacy by the social constructivist education approach. The learning experience of design students in digital environments is designed as a simulation of the critical culture in face-to-face design education and the social interaction brought by the working environment. For this reason, it is thought that the applied design courses are conducted on platforms that can support digital collaboration and reflect on students' own creative and design skills.

For this reason, this research aims to frame the affective learning outcomes of distance design education in higher education. Besides that, the study questions what the effects of applied design education in the concept of distance education are over the first-year industrial design students' design and creative self-efficacy and their visual literacy. In this context, it aims to shed light on how students' Creative Self-Efficacy, Design Self-Efficacy and Visual Literacy scores have changed through teamwork and the use of different digital tools.

Literature Review

A brief discussion of learning outcomes and cognitive skills will be made in this section, followed by a look at the social cognitive theory approaches of learning. A lasting improvement in behaviour as a result of an action is referred to as learning (Wexley & Latham, 1991). As a result, instructional goals, learning objectives, and outcomes are all intertwined with the learning experience.

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The instructional goals are quantifiable techniques that define the abilities that a student acquires after completing a learning task (Kibler, Cegala, Miles & Barker, 1974). Learning goals, on the other hand, play a tactical role in education, supporting observable behaviour and skills. The learning goals highlight what students will be able to achieve as a result of their learning experience. Finally, the learning outcomes are designed to direct the student through the process of connecting information for the student to explore and incorporate the gained knowledge's capacity in a variety of contexts. The learning outcomes often enable students to focus on and assess their progress during a course or program.
The learning outcomes are manifested at the cognitive, skill-based, and affective stages (Kraiger, Ford & Salas, 1993). Cognitive stability is achieved by the ability to maintain autonomy and awareness of the world, as well as the internalization and externalization of experiences (Fosnot & Perry, 1996). To put it another way, cognition is the relationship between a set of variables and varying quantities, forms, and elements of information (Lord & Mahler, 1991). Cognition expresses itself in the context of verbal awareness, knowledge organization, and cognitive techniques in learning outcomes (Gagne, 1984).
Secondly, having a set of goal alignment and activities that are structured sequentially and hierarchically is referred to as skill development (Weiss, 1990). The phases of development creation start with the learning of new skills, followed by the compilation of those skills by proceduralization and composition, and finally, skill automaticity. Understanding learning outcomes solely based on cognitive and skill-based attributes is insufficient. Affective outcomes, such as self-efficacy and motivation (Krathwohl, 1964), also influence the overall learning experience.

Self-Efficacies in Design Education

Self-efficacy is described as a person's confidence in his or her ability to effectively perform required behaviours to produce the desired result or to effectively complete a specific task (Bandura, 1977, 1995a & Pintrich, 1999). Self-efficacy (Bandura, 1989), used in education, communication, and psychology, is a theory that argues that knowledge is formed by observation, interaction, experience, and external media factors. With social impact, knowledge and meaning are formed, environmental and personal factors linked to behaviour are interdependent, and every action has an impact. Bandura argues that with basic interventions, people can gain many behavioural tissues. The effects of the physical and social environment on people are also emphasized. It is advocated that it provides self-confidence through interactive learning and practice. Learners build information by social interaction with other individuals in the interactive constructivist approach, so learning construction is considered social. Reflections on social experiences help to build awareness (Henriques, 1997). The constructivist learning approach is based on the following principles: the learner's prior and current experience is valued, pedagogy is shaped by this, education is constructed actively by the learner in both individual and social ways, and comprehension is a process of adaptation (Olssen, 1996). Understanding self-efficacy is particularly useful for designing intervention strategies to help students learn better. Carberry, Lee and Ohland (2010) discuss the need for understanding student learning and effective teaching in education as below:

> *Knowing an individual's self-efficacy serves as a valuable supplement to their cognitive gains, they claimed. Understanding how self-efficacy influences student learning will aid in the improvement of intervention strategies to help students perform better (p. 77).*

Improvements that occur in self-perceptions of creative efficacy contribute to increases in creative efficiency, so creative self-efficacy growth is beneficial. Creative self-efficacy refers to a person's confidence in his or her own ability to be creative. CSE is described by Abbott (2010, p. 12) as a motivational condition characterized by an individual's self-efficacy for expressing creativity and an individual's confidence in one's own ability to express creative efficiency.
Design self-efficacy is described as the “extent to which a person feels confident to perform well on the design aspects of the job” (Beeftink, van Eerde, Rutte & Bertrand, 2012, p. 73). Design self-efficacy can be characterized as an individual's confidence in his or her ability to effectively perform expected behaviours to create a design or effectively complete a design mission, according to the definitions of Bandura (Bandura, 1977, 1995a) and Pintrich (1999). A higher level of design self-efficacy is linked to becoming a more effective designer (Beeftink et al., 2012). Self-efficacy is thought to be enhanced by repetitive practice in self-regulation, and self-efficacy can contribute to the controlling behaviour and emotions required for success in design and business. Developing an innovative cognitive style, also referred to as Innovative Cognitive Style, is found to have a positive impact on creativity (Shalley, Zhou & Oldham, 2004). The control theory of self-regulation proposes that task completion necessitates repetitive cycles of feedback loops to keep track of task progress.

There is a popular discussion on how the view of self on creative tasks affects actual, evidence-based, creative performance (Tierney & Farmer, 2002), with the belief that creatively confident people may perform better in creative tasks (Kelley & Kelley, 2013). One way of assessing self-efficacies in creative tasks is through the Creative Self-Efficacy Scale (Tierney & Farmer, 2002). The scale assesses the self-confidence in creative aspects of a task, whereas Design Self-Efficacy Scale (Beeftink et al, 2012) assesses the self-confidence in the performing of a design aspect of a task. In this study, the culturally adapted Turkish scales by Atabek (2020) for both will be used as the tools to reflect how the students perceive their creative and design abilities. Additionally, the Visual Literacy Scale will be used to assess how much the students are aware of and have adapted to the visual world of design, such as the use of visual tools and principles.

Case Study: Introduction to Industrial Design Course

This study was made with the students enrolled in the Introduction to Industrial Design I course at Yaşar University Department of Industrial Design. The period of the study is the 2020-2021 Fall Semester. The students who have taken the course are a total of 36. However, the number of students who have completed both the pre-test and post-test are 11 male, 15 female students, a total of 26. In this study, the data of participants who have taken both tests will be analysed to develop an understanding of how the course has transformed them.

Table 1. Information on the participants enrolled in the course

	Female	***Male***	***Total***
Number of Participants	*15*	*11*	*26*
Average Age	*18.1*	*18.8*	*18.4*

The common characteristic of the participants of the study is they are first-year students, 18.4 years old in average, who have not taken any design-related courses. It must be noted that the first-year compulsory courses the students must succeed in are developed for transforming a non-designer into a beginner level designer. Four compulsory courses are in the educational plan of the Product Design Department in Yaşar University for the first-year fall semester: Basic Design I, Technical Drawing I, Freehand Drawing I, and Introduction to Industrial Design I.

In the first year of industrial design education, the Introduction to Industrial Design course plays a synthesizing role between compulsory design courses such as Basic Design, Freehand Drawing, and Technical Drawing. Not only that but also the course presents an introductory level design culture and knowledge for familiarity. Considering that the practice and application of the knowledge acquired is more holistic, for this paper the Introduction to Industrial Design course was chosen as a case.

The course is 4 hours a week incorporating two design projects and one research project. The course consists of one instructor, one research assistant and 36 students. At the end of the course, the students are expected to learn cognitive, skill-based, and affective aspects of design as described in the following. The content of the course includes the methods of idea exploration, idea development and transforming ideas into 3D designs. It consists of exercises of three-dimensional (3D) thinking related to product design, comprehending basic geometrical shapes, sketching, abstract thinking on two and three-dimensional relations, improving physical 3D modelling and experiencing various modelling techniques with different materials. In other words, the course outline requires the development of creative, design thinking skills concerning an improved literacy in the visual world.

Data Collection

The digital tools used during the course can be categorized by the roles attributed to the usage of those tools such as communication, collaboration, and assessment. As for the communication role, the Zoom Video Conferencing platform was used to provide instructions and facilitate in-class discussions (Figure 1). Additionally, the Breakout Room function of Zoom was used in each class for group works, planning and peer-review.

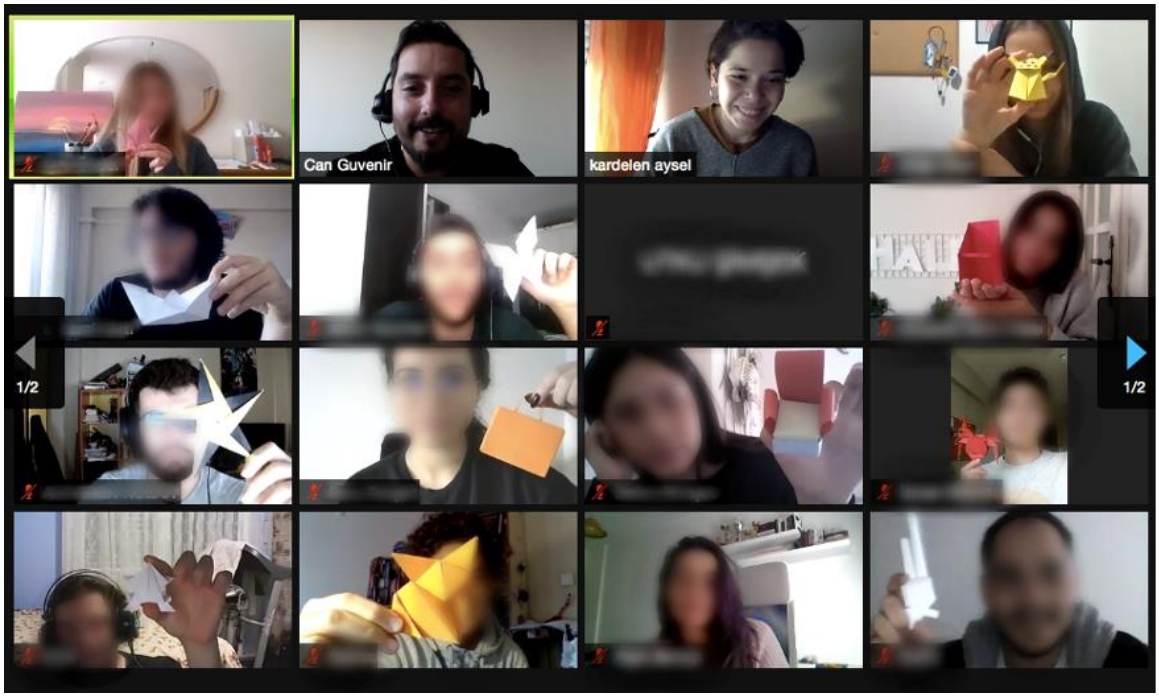

Figure 1. Screenshot from first project jury

Secondly for collaboration, the students presented, reviewed, commented, archived, and submitted their works on the classroom board on Miro. As a digital whiteboarding platform, the characteristics of pre-pandemic, face-to-face experience was imitated for the students to be able to adapt to this new system easier. Lastly, for the role of assessment, Google Forms were used for both quantitative and qualitative reviews. During each presentation and project juries, the students evaluated themselves and other students according to the survey template provided. Moreover, through Google Forms, the students were asked to review and reflect upon the learning experience.

At both the beginning and the end of the course the students were asked to fill out forms that will be used as pre-test and post-test. The quantitative survey consists of the Creative Self-Efficacy Scale, Design Self-Efficacy Scale, Visual Literacy Scale and Peer-Review survey. Scales used in the data collection stage are culturally adapted to obtain more consistent data.

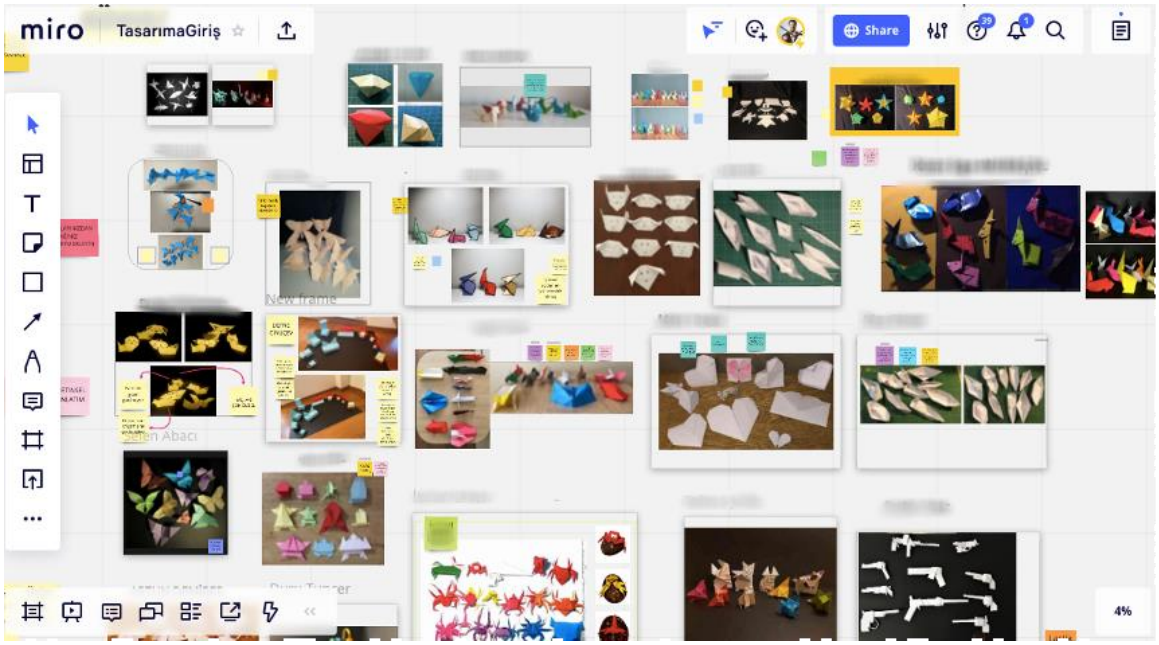

Figure 2. Course's Miro Board

Additionally, evaluation criteria for students, which are also filled out at the final submissions of two projects and one research paper were presented. The qualitative data collection was also made through peer-review forms where the students evaluated themselves and each other by writing a paragraph-long critique including positive and improvable comments (Table 2). The survey's overall form was designed to allow students to evaluate the abilities they learned in each semester. They were asked to assess the design projects based on each course's learning outcomes. The purpose of this assessment was to project design students' skill transfer concerns. Students were asked to use Miro and Google Forms at the same time during the peer-review process. Students completed the survey questions while looking at the projects on the class Miro Board.

Table 2. Template for the peer-review form

Class Evaluation Form for Project 1							
Name-Surname: _____							
Please select what fits the project most (5 is the highest)		1	2	3	4	5	
Student 1_name-surname	Idea - Investigation	o	o	o	o	o	
	Design Process	o	o	o	o	o	
	Workmanship	o	o	o	o	o	
	Overall Presentation	o	o	o	o	o	
	Comments	*Write your comments on the project. What are the positive aspects and what can be improved in what ways?*					

Together with the forms, the students were asked to review the learning experience at the beginning, during and end of the class through a reflective writing activity (Gelmez, 2016). The reflective writing survey included questions regarding the students' feelings, experiences, and perspectives on the course. Its goal was to discover the connections between the student's prior knowledge and experience and what they learned in class. In addition, the survey inquired as to how the student would behave differently if the course were to be repeated.

The study conducted within the Introduction to Industrial Design I course was during the 2020-2021 Fall Semester, which was 16 weeks including the final juries. In the 4th week of the course, a pre-test was done, consisting of the CSES, the DSES, the VLS, reflective writing survey and peer-review forms. The same set of tests, as post-test, was also completed at the end of the 16-week course period to collect data for evaluating the contribution of the course content to the students through comparison.

Findings and Discussion

Affective learning outcomes in industrial design education were researched under the title of self-efficacy, focusing on creativity and design, additionally the learning outcomes were assessed under the title of visual literacy. For this, the surveys for the assessment of the creative and design self-efficacy followed by the visual literacy was completed by the students. The assessments were applied at the beginning, the middle and the end of the training process. The data were analyzed and evaluated separately. The analysis of the data was compared and confirmed through students' reflective writing results and peer-reviews. Within this framework, distant synchronous applied industrial design education has been evaluated from the perspective of learning outcomes, students' design-related skill acquisition, creativity, and visual expressions under the title of self-efficacy through the social constructivist model, modified for the digital environment. While no significant change has been observed in the creative self-efficacy levels of the students, the design abilities and visual expression skills have transformed significantly. Design-wise, an increase has been observed in the process of overcoming problems, application of visual materials and typography, the production of static and animated visuals, and the examination ability of visuals.

The survey results, consisting of the culturally adapted questions of the CSES, DSES and VLS, were tested for reliability and validity. The students who did not participate in all 3 sets of questionnaires were excluded from the study, resulting in N=26. Due to the number of students and questions, the results were not found suitable to infer a typology (Phelan & Wren, 2007). Changes in mean values have been looked at (Appendix 1),

additionally, the inferences were made through the changes in p-values. To increase the objectivity of the study, the questions that present a p-value below 0.05 were considered unchanged, therefore excluded from the findings.

No significant change was observed in the creative self-efficacy values of students. In DSES, the students' self-perception on overcoming and satisfying design issues were improved. As mentioned by Participant 18, “We used to solve problems we come across from the easiest way but this time, through exploring it together we could think of more and more creative alternatives”. Not only that but also design-wise, Participant 11 commented that the course was helpful for self-awareness with the quote, “This course revealed so many things in me that I have not known about myself before, I can be creative and design”. Lastly, on the design-based confidence, the peer-reviews were found to enable awareness over own skills as Participant 4 mentioned, “I feel happy because my friends were interested in the ideas that I shared during teamwork, and I saw that I can think of good ideas”.

As well as self-awareness, the social aspect of the design studio was found to be beneficial for the students as Participant 7 described: “I believe the course has taught me to observe the environment by firstly asking the *why* question, the instructors always took our opinion on the course activities. This way, the course structure allowed me to participate in the in-class activities and projects”. The interactive nature of the course was found to be enabling in terms of motivation, “I think, making an interactive studio course made me more focused and motivated for participation” (Participant 9). Still, some students needed face-to-face education with the applied studio courses, “The course being online had disadvantages as well as advantages. The in-class activities were fun and educative, but I think face-to-face education would be more effective” (Participant 4).

Additionally, the awareness over self-discipline was discussed to be an important gain of the course as Participant 22 stated: “The tasks with sharp deadlines helped me to be more disciplined”. Self-discipline did not only have the role of facilitating a systematic course experience for the students. “My perception and perspective over design expanded. I have learnt how to cope with limitations and force myself to continue. This way I have taken big steps within the scope of a semester” (Participant 17).

The visual literacy levels of the participants were found to be improved during the semester. The use of design elements such as drawings, appropriate fonts and hierarchizing text with basic design principles increased. Not only that but also Participant 4 has mentioned the learning experience of visualization, “I realized drawing for communication, sketchnoting, is parallel to my notetaking style. It was nice to incorporate this to the class”. Secondly, overall, the use of visual design principles such as the framing of images, and developing limitations for own design increased. In addition, the students’ level of performing the visual design skills was assessed by the level of workmanship. In this study, it was found that there was an increase in the usage of tools for documentation, editing and presentation. As Participant 12 comments, “Before the class, I have never made a presentation which made me scared. And at first, I didn’t know my limitations and tools. But over time, I have felt more capable of expressing my work by learning new digital tools”.

Overall, it can be inferred that the students have developed visual awareness and inquiry in the first semester. Those who were negatively reviewed in terms of workmanship and quality of design outcomes have claimed it to be a path that needs to be improved. For this, Participant 13 has written “It was a fun course, however, I felt insufficient and upset because of not being able to draw what I imagine, I should spend more time on improving myself on that”.

Conclusion

This paper aims to shed light on the creative development of the individual in the process of becoming a designer from a non-designer within a digital educational setup. For this, the first-year industrial design students were assessed by evaluating their creative self-confidence, design self-efficacy within the framework of visual literacy. The findings suggest that continuous peer-review and self-assessment activities deepen the students’ awareness of self over creative and design skills through collaboration. Along with this, the researchers' observation is that they provide increased student participation and engagement in an introductory design lesson in a virtual environment.

Although the creative self-efficacy levels of students do not increase, detailed future studies regarding the increase in design self-efficacy is important to be done. In other words, the self-perception of the students about producing original and creative ideas did not change, however, their view of themselves on problem-solving changed positively. The positive change in the design self-efficacy levels might be due to the students’ concrete experience of the problem definition and solution, causing increased awareness over the designerly skills. On the other hand, the awareness over own creative skills may require the ability to assess an idea in

terms of its novel qualities and innovative characteristics. For the first semester of industrial design education, these aspects of a product may be difficult to address. Thus, the students may not be able to assess their own creative skills objectively. This situation may be due to the structure of design education, or it may have occurred due to distance education during the pandemic period.

Additionally, the compulsory use of digital tools may have forced students to improve their visual communication and questioning the skills of expression channels. We believe that the advantages of this situation specific to distance design education resulted in the students' development of self-awareness on visual literacy, besides, the practical use of visual tools and the visual communication focus of design education have increased the effect on visual literacy. Likewise, we believe that increasing the visibility of the design process through using the visual tools used with peer-reviewing as a common sharing platform was beneficial for the students' interaction, facilitated through continuous visual output, problem-solving and visual communication by reflecting on the design processes.

This study has shown that design tools, processes and activities contribute to design self-efficacy and visual literacy in the early development of designerly mindset within the scope of design education. On the other hand, the course did not affect the development of creative self-efficacy and brought the question of the relationship between problem-solving skills and creativity. We think that a more in-depth investigation of this topic can open space for discussion on design education, design tools and methods through the perception of design-based creativity.

The mentioned improvements may be supported with the course flow and requirements such as repetitive practices and reflection sessions made on design presentation boards and presentation videos. The area of the subject needs to be researched in more detail to obtain more specific results. Also, the digital collaboration tools that were used in this study is a growing area in design education, specifically with the distance education due to the Covid-19 pandemic. For this, investigating the adaptation of digital collaboration tools in design education will be beneficial for both parties: students and instructors.

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Appendix 1. Analysis of student forms

	Before		*After*		
	Mean Value	*Variance*	*Mean Value*	*Variance*	*p-Value*
CSE1	3.79	0.69	4,04	0.73	0.16
CSE2	4,20	0.34	4.29	0.56	0.53
CSE3	4.29	0.38	4.29	0.65	1,00
DSE1	**3.54**	**0.51**	**3,95**	**0,65**	**0,01**
DSE2	**3,58**	**0,68**	**4,04**	**0,56**	**0,00**
DSE3	3,45	1,30	3,62	0,94	0,50
DSE4	4,08	0,60	4,00	0,60	0,64
DSE5	4,08	0,77	4,04	0,56	0,84
DSE6	2,08	1,81	2,25	1,41	0,59
DSE7	3,87	0,63	4,08	0,60	0,30
DSE8	3,91	0,68	3,62	1,28	0,25
VLT1	**4,00**	**1,13**	**4,54**	**0,34**	**0,00**
VLT2	4,08	1,03	4,33	0,66	0,31
VLT3	3,16	1,53	3,20	1,04	0,86
VLT4	2,75	1,41	2,83	1,27	0,75
VLT5	3,91	1,21	4,20	1,47	0,32
VLT6	**3,91**	**1,03**	**4,37**	**0,50**	**0,05**
VLT7	**4,20**	**1,12**	**4,58**	**0,34**	**0,05**
VLT8	3,29	1,51	3,45	1,65	0,51
VLT9	3,75	0,89	4,04	0,73	0,12
VLT10	2,79	1,12	3,12	1,24	0,06
VLT11	3,91	1,21	4,08	0,94	0,23
VLT12	4,00	0,69	4,16	0,49	0,25
VLT13	4,41	0,77	4,16	0,92	0,11
VLT14	4,45	0,78	4,62	0,41	0,29
VLT15	4,37	0,41	4,50	0,60	0,45
VLT16	4,29	0,56	4,41	0,60	0,41
VLT17	4,41	0,68	4,45	0,86	0,84
VLT18	4,45	0,69	4,66	0,57	0,34
VLT19	4,75	0,19	4,66	0,31	0,16
VLT20	4,50	0,60	4,58	0,60	0,42
VLT21	4,37	0,67	4,60	0,50	0,08

VLT22	**3,45**	**1,91**	**4,45**	**0,69**	**0,00**
VLT23	2,83	2,31	3,04	3,08	0,46
VLT24	**3,41**	**1,99**	**4,00**	**1,30**	**0,04**
VLT25	2,20	1,82	2,75	2,97	0,16
VLT26	**2,12**	**1,67**	**3,54**	**1,65**	**0,00**
VLT27	**2,87**	**1,67**	**3,62**	**1,28**	**0,01**
VLT28	4,16	0,57	4,20	0,60	0,83
VLT29	**3,70**	**0,99**	**4,20**	**0,86**	**0,02**

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