Pakistan Journal of Distance & Online Learning
Volume: IX, Issue I, 2023, xx–xx

Online Flipped Classroom in the Context of Transactional Distance and Cognitive Load: A Mixed-Methods Study*

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Abstract

This study aimed to evaluate the Online Flipped Classroom (OFC) instruction process in the context of Transactional Distance (TD) and Cognitive Load (CL). The study was conducted using a mixed-methods design. The participants were nine graduate students. One of them participated in the process asynchronously and seven of them participated synchronously, and the one member was irregular. Transactional Distance Scale and Subjective Rating Scale were used to collect quantitative data. Interviews were conducted to gather qualitative data related to OFC instruction process. All of the TD measurements for the asynchronous and irregular students were low. The synchronous students' TD measurements were low when OFC began, becoming very low later on. The asynchronous student felt cognitive load during some of the OFC activities. Synchronous and irregular students felt the cognitive load during almost all the OFC stages. The future studies may focus on measuring the types of CL and collecting qualitative data to determine the CL type may contribute to the literature.

Keywords: *Online instruction, flipped classroom, transactional distance, cognitive load, higher education*

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Introductıon

We can define distance education (DE) as an educational model in which teachers and students are in different locations. They communicate with each other using the means supplied by Information and Communication Technology (ICT). In this context, ICT is the medium that conveys the instructional content and instructional materials. If we mostly use the internet, we can call this type of instruction online instruction. This process must have a pedagogical dimension. With suitable pedagogy, the online instruction process will be more efficient. Presently, ICT is used more frequently and as a result, some models such as Flipped Classroom (FC) are more popular (Bedi, 2018).

Dialectic of FC depends on doing classroom activities at home, then doing home activities (i.e., homework) in a classroom (Bergmann ve Sams, 2012). Video tutorials can provide students with the prerequisite knowledge and skills before class, giving the students a background for the class activities (practices and discussions) (Fung, 2020). Effective outcomes can be achieved in class and this can be ensured by using effective class activities, facilitating interaction with ICT, and integrating pedagogical models into suitable learning domains (Konijn, Essink, Buning & Zweekhorst, 2018; Cheng, Ritzhaupt, & Antonenko, 2019; Zheng, Bhagat, Zhen & Zhang, 2020). In the literature, these effective results can be summed up with the titles positively contributing to learning outcomes, contributing to students' affective features, contributing to students' learning motivation, and increasing student-student / student-teacher interaction (Günbatar, 2021a).

FC provides students with time and space flexibility in blended and online learning environments (Thai, De Wever & Valcke, 2020) and serves as a suitable environment for individual learning (Colomo-Magaña, Soto-Varela, Ruiz-Palmero & Gómez-García, 2020). It owes this flexibility to the technology it uses (Bedi, 2018). Its flexible structure has allowed many different models to be developed to implement FC (Gómez-Tejedor, Vidaurre, Tort-Ausina, Molina-Mateo, Serrano, Meseguer-Dueñas, ... & Riera, 2020). Based on the high performance of the students involved in the FC process in the e-learning environment (Thai, De Wever & Valcke, 2020), completely online FC implementation models emerged (Stöhr, Demazière & Adawi, 2020).

Literature Review

It is important to construct FC related studies atop strong theoretical frameworks (Konijn, Essink, Buning & Zweekhorst, 2018; Stöhr, Demazière & Adawi, 2020). Otherwise, the result would be superficial and

ungrounded studies. Interaction and collaboration are important variables (Kayaduman, 2020; Thai, De Wever & Valcke, 2020; Zheng, Kim, Lai & Hwang, 2020) because students' feelings of loneliness and lack of social learning are prior causes of the basic problems (Dinçer & Doğanay, 2017). In addition, Cognitive Load (CL) emerges as an important variable in students' individual learning, and this variable has not been studied enough in the FC literature (Cheng, Hwang & Lai, 2020). Evaluation studies should determine how students acquire new knowledge through social interaction (Park & Kim, 2021) and communication and interaction in the FC instruction process could be considered (Karaoglan-Yilmaz, 2017; Lee & Kim, 2018; Günbatar, 2021b). Transactional Distance (TD) could present an important conceptual framework for evaluation studies (Stöhr, Demazière & Adawi, 2020). Additionally, in the FC process, in-depth studies should be conducted (Bedi, 2018; Sergis, Sampson & Pelliccione, 2018; Martínez-Jiménez & Ruiz-Jiménez, 2020) considering students' individual experiences (Martínez-Jiménez & Ruiz-Jiménez, 2020), point of view, and perceptions (Jdaitawi, 2020). Mixed-methods are recommended in this context (Cheng, Hwang & Lai, 2020). For the reasons stated above, this study aims to evaluate the entire online instruction process supported FC pedagogy in the context of TD and CL.

Conceptual Framework

Theory of Transactional Distance

According to Michael G. Moore, DE is not merely the setting that separates students and teachers geographically. The pedagogical aspect of DE is very important, too. This section summarizes TD within the context of the study according to Moore's (1993) Theory of Transactional Distance, separating the associated special instructional procedures into three clusters, namely, Dialogue, Structure, and Learner Autonomy.

Instructional Dialogue

Dialogue and interaction are very similar terms, and are often used synonymously. Interaction can be negative or neutral. The term dialogue mentioned here is also estimated to mean a positive interaction. The characteristics of the communication media used in DE processes matter at this point. When we consider the situation where one-way communication (television, video recording e.g.) between teacher and student is allowed, there is little teacher-learner dialogue and TD is high. TD is low in environments where two-way communication is allowed. The most important determinant of dialogue in instructional environments is the communication media's interactive nature.

Program Structure

The second set of variables consists of the elements of course design. They have a prominent effect on TD. The structure determines the rigidity or flexibility of the instructional goals, teaching strategies, and assessment methods. The structure is significantly affected by the nature of the communication media used. When we treat recorded television programs as media, they can be said to be highly structured. Compare it with a teleconference environment that provides us with reciprocal communication. Teleconferencing allows us more dialogue but has less structure. If the program is highly structured and there is no teacher-student dialogue, teacher-student TD is high. TD is low in teleconference programs, which have more dialogue and a less predetermined structure.

Autonomy of the Learner

Students' ability to share responsibility for their own learning can be neglected in the DE process. Students with advanced skills (i.e., self-directed learners) are more comfortable in programs that have less structure and more dialogue. More dependent learners prefer programs that have more dialogue. Some students want highly structured programs. Other students rely on an informal structure that provides a close relationship with teachers.

Reflections of Dialogue, Structure, and Autonomy on Transactional Distance

Relationships between dialogue, structure, and learner autonomy are expected. High structure and low dialogue in a program produce more autonomy for learners. Student autonomy increases with TD, and this to do with studying strategies. Learner autonomy matters because student characteristics in the teaching-learning process are important. Establishing an appropriate dialogue setting to satisfy student demands requires multiple skills. It requires changes in the traditional teacher roles and provides the basis for selecting the teaching environment.

Cognitive Load

We can think of cognitive load as the mental workload an individual feels when performing a task (Liao, Chen & Shih, 2019). The capacity of working memory is greater than seven for judgments that are not multidimensional (Miller, 1956). We can define Multimedia Learning as learning from words and images. Words can be in written form or expressed verbally. Images can be static or dynamic (Mayer & Moreno, 2003).

The literature also mentions intrinsic, extraneous, and germane cognitive load types (Akkaraju, 2016; Mutlu-Bayraktar, Cosgun & Altan, 2019; Albus, Vogt & Seufert, 2021; Skulmowski & Xu, 2022). According to Cognitive Load Theory, intrinsic load is related to a basic problem or

concept in the context of the learning content and does not change. For example, the concept of the square. It is a shape that has four equal sides and four equal angles. The extraneous load is related to the cognitive load, which has the potential to make learning tasks more difficult. When we continue with the example of the square, to represent the square concept in words requires additional load. Just drawing a square much simpler. The germane load is related to constructing schemata in long-term memory. Germane load occurs, for example, if we draw squares of different sizes or orientations and then students interpret them (Abeysekera & Dawson, 2015).

Methodology

Research Design

Within the scope of the research, a one-semester course process was carried out in accordance with the OFC model. TD and CL levels of the participants were measured quantitatively. Interviews related to TD were conducted and qualitative data obtained. The students participating in the Online Flipped Classroom (OFC) process have three characteristic features. So the author analyzed the data of the three different types of learners; synchronous, asynchronous, and irregular. They first obtained quantitative data, then conducted interviews to obtain qualitative data. Therefore, the study used the mixed-methods model (Freankel & Wallen, 2009).

Study Group

The study group consisted of graduate students from the Faculty of Education, then studying for their master's degree in the Computer Education and Instructional Technology (CEIT) Department. It is not possible to study with large group of students at master's level. Because the number of students is limited. The study group consists of nine students in total. They took the master's degree course named Instructional Message Design. They participated the course as a class and the course was conducted with OFC model. The participants' demographic data are provided in table 1.

Table 01
Participants' Demographic Information for OFC Participation

Students	Gender	OFC participation
S1	Male	Asynchronous

S2	Female	Synchronous
S3	Female	Synchronous
S4	Female	Irregular
S5	Male	Synchronous
S6	Female	Synchronous
S7	Female	Synchronous
S8	Female	Synchronous
S9	Female	Synchronous

While looking at table 1, it can be observed that one student was asynchronous, one student was irregular, and the remaining seven students were synchronous. The asynchronous one did not participate in live course sessions and followed the course recording afterward asynchronously. The irregular one early on in the semester joined the class regularly, her participation became irregular later. The synchronous students participated in all live course sessions.

Data collection tool and analysis

Quantitative Data Collection

The Transactional Distance Scale (TDS) and Subjective Rating Scale (SRS) were used to collect quantitative.The Turkish version of Zhang's (2003) TDS, adapted to Turkish culture by Yılmaz & Keser (2015), was used to measure TD. The TDS is a five-point Likert-type scale. Since the scale is a five-point Likert-type scale, the measurement results were split into five levels. The mean scores obtained from the TDS were interpreted as 1.0-1.8 "Very high"; 1.8-2.6 "High"; 2.6-3.4 "Medium"; 3.4-4.2 "Low"; 4.2-5.00 "Very low," respectively. TD measurements were taken at four-week intervals and three times. The first data was obtained early in the semester, the second in the middle, and the third one late in the semester.

Paas & Merrienboer's (1993) SRS, adapted to Turkish culture by Kılıç & Karadeniz (2004), was used to measure CL. It has one item and works by scoring the cognitive load 1 to 9 for a given situation. The midpoint of the scale is five. Scores above five indicate cognitive overload. Scores below five indicate no cognitive overload. CL measurements were taken late in the semester. Participants' CL levels were determined through "*when they were watching class preparation videos*" "*when they were in class*

discussions" "*when they were evaluating instructional material*" and "*when they were writing a reflection paper*".

Qualitative Data Collection

The students were interviewed individually during the last week of OFC instruction to gather qualitative data in order to obtain detailed information about TD. The students were asked questions about the components of TD (Structure, Dialogue, and Learner autonomy).

Instruction

OFC instruction activities were carried out within the context of the Instructional Message Design course which was a graduate-level course. It was conducted over one semester from 5 March 2021 to 18 June 2021. The course involved discussing how an instructional message must be presented to students both in face-to-face settings and in instructional materials. Important issues were examined regarding content types. The weekly distribution of instructional activities was presented in Table 02.

Table 02

Weekly Instruction Contents

Date	***Subject***
03.05.2021	Instructional materials, tools/equipment, and their properties. Informing students what OFC is.
03.12.2021	Motivation principles.
03.19.2021	Evaluating instructional material according to motivation principles.
03.26.2021	Perception principles.
04.02.2021	Evaluating instructional material according to perception principles.
04.09.2021	Psychomotor learning principles.
04.16.2021	Evaluating instructional material according to psychomotor learning principles.
04.30.2021	Cognitive learning principles.
05.07.2021	Evaluating instructional material according to cognitive learning.
05.14.2021	Concept learning principles.
05.21.2021	Evaluating instructional material according to concept learning principles.
05.28.2021	Problem-solving principles.
06.04.2021	Evaluating instructional material according to problem-solving principles.
06.11.2021	Affective learning (attitude) principles

Date	*Subject*
06.18.2021	Evaluating instructional material according to affective learning principles.

OFC Implementation Model

The OFC model used in this study had four steps.

1. Sending the instructional video (Via LMS and WhatsApp): The lesson preparation video was shared via LMS and WhatsApp by the instructor one week before the class.
2. Online class discussions: During the lesson, discussions regarding weekly topics were held online.
3. Evaluating instructional material: All students selected and evaluated pre-prepared instructional materials. The materials were related to the topic discussed the previous week and were evaluated according to Instructional Message Design Principles. The instructor and peers assisted each student with their comments.
4. Writing a reflection paper: Each topic took on average two weeks. The students wrote a reflection paper on each topic.

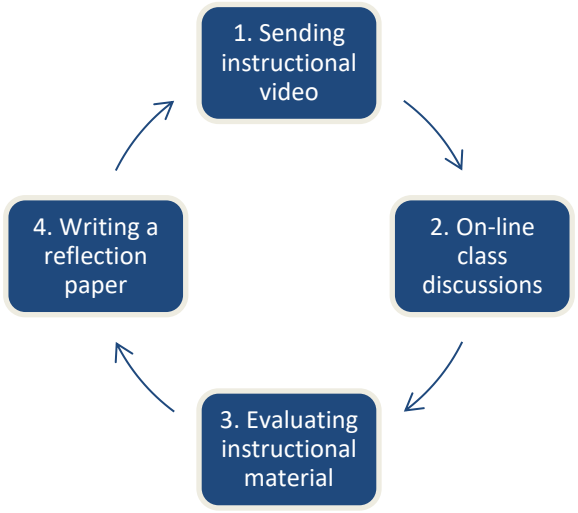

Figure 01. The OFC implementation model used in the study

Results and Discussion

Results

This section presents the findings of the students who participated in OFC instruction in three different ways (asynchronously, synchronously, & irregularly), respectively.

Asynchronous Participant's Transactional Distance Measurements

Table 03

Asynchronous Participant's TD Measurements

Students	m1	Level	m2	Level	m3	Level	m Mean	Level
S1	3.97	L	4.16	L	4.08	L	4.07	L

L: Low *m:* Measurement *S:* Student

There are three TD measurements and their levels were given in Table 3. S1 did not participate in live course sessions. He followed the course recording afterward asynchronously. Although he fulfilled the requirements in all activities, all three measurements are at a low level. There is no fluctuation across the TD measurements.

Asynchronous Participant's Opinions on Transactional Distance

S1's opinions on the Structure, Dialogue, and Learner autonomy themes, which are sub-dimensions of TD, were presented in Table 04.

Table 04

Asynchronous Participant's Opinions

Theme	Sub-theme	Sample expression
Structure	Well structured	*S1: I found the instructional process design original. It was good for me because I could not participate in the live class activities…I did not need to search for information, I learned from the video-based learning materials.*
Dialogue	Good communication with peers	*S1: Because of my schedule at school, I could not participate in the live lessons. My friends did not help me to set the live class time, and as a result, I wasn't on good terms with them in the early semester. Apart from a few of them, my communication with them was*

Theme	Sub-theme	Sample expression
		good, healthy, and focused on sharing.
	Good communication with the instructor	*S1: Communication with the instructor was good. The instructor listened to our problems.*
	Seamless communication with instructional content	*S1: I didn't experience any technical issues so I had no problem communicating with the instructional content. The instructional content used simple expressions.*
Learner autonomy	External control	*S1: Writing a reflection paper and discussing the course content made learning the content more permanent. We did these activities weekly and regularly, and they encouraged and challenged us to learn.*

From Table 04, we can see under the *Structure* theme that S1 thought the OFC as constructed rather well. Under the *Dialogue* theme, he finds the interactions with the other friends to be good overall and also with the teacher. He said he understood the course content easily. Under the *Learner autonomy* theme, the expressions he used indicated that there was much external control.

Asynchronous Participant's Cognitive Load

Table 05

Asynchronous Participant's CL Measurements

Students	Watching course videos	Class discussions	Evaluating instructional material	Writing a reflection paper
S1	2	5	7	6
Level	Very low	Neither low nor high	High	Partly high

In Table 5, S1 has five separate levels of CL. He felt the most CL while evaluating the instructional material. He felt the least CL while watching the course videos.

Synchronous Participants' Transactional Distance Measurements

Table 06

Synchronous Participants' TD Measurements

Students	m1	Level	m2	Level	m3	Level	m Mean	Level
S2	3.92	L	4.32	VL	4.32	VL	4.19	L
S3	4.16	L	4.21	VL	4.32	VL	4.23	VL
S5	4.82	VL	4.76	VL	4.61	VL	4.73	VL
S6	4.21	VL	4.24	VL	4.16	L	4.20	VL
S7	4.13	L	4.13	L	4.16	L	4.14	L
S8	3.92	L	4.47	VL	4.58	VL	4.32	VL
S9	3.95	L	4.11	L	4.61	VL	4.22	VL
Mean	4.16	L	4.32	VL	4.39	VL	4.29	VL

VL=Very Low; *L=Low; m*=Measurement; *S:* Student

When we examine Table 6, we can see the TD measurements and levels of the students who regularly participated in the OFC. The first measurements for S2, S3, and S8 are low but their second and third measurements are very low. All three of S5's measurements are consistently very low. The first two measurements for S6 are very low but his third measurement is low. All three of S7's measurements are low. The measurements for S9 tend to increase consistently with the first two measurements being low and the last measurement very low. When we look at the measurement means, the first measurement mean is low ($\bar{x}$=4,16), the second measurement ($\bar{x}$=4,32) and the third measurement ($\bar{x}$=4,39) means are very low. The synchronous students' individual TD measurement tendencies were provided in figure 01.

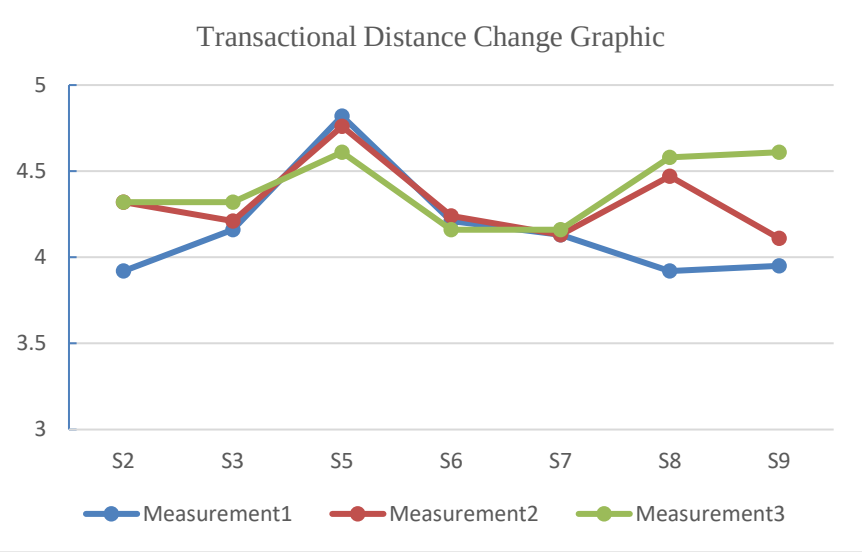

Figure 01. Synchronous Participants' TD Changes

If the TDS score is high, it means that the student's perceived transactional distance is low (Yılmaz & Keser, 2015). When we look at Graphic1, there are gaps between the first and second measurements for S2 and S8. There is a gap between the second and third measurements for S9. This means that TD decreased between these measurements. Other than that, there is no obvious fluctuation.

Synchronous Participant's Opinions Concerning Transactional Distance

Seven students participated regularly and synchronously in the OFC. Their qualitative data were presented in Table 07.

Table 07

Synchronous Participants' Opinions

Theme	Sub-theme (Frequency)	Sample expression
Structure	Well-structured (3)	*S9: I learned a lot from the process…It was efficient because we were constantly repeating the content before the class, during the class, and while evaluating the material. Thanks to the OFC, I repeated a topic three times.*

Theme	Sub-theme (Frequency)	Sample expression
	Opportunity to express themselves (6)	*S6: If the instruction process were traditional distance education, we would probably get information passively, and would not be able to express ourselves...Thanks to the videos we w*ere able to come to class prepared and discuss *the course content…We discussed it using some examples and we learned from the other people's ideas.*
Dialogue	Increasing communication throughout the OFC process (4)	*S2: I think communication must be face to face. I am in favor of reciprocal mimics, gestures, and eye contact. That's why I was negative about the process at first … Both evaluating the instructional materials and contributing to my peers' material evaluations made me socialize with classmates … now I feel as if I've known my classmates for a long time. That's why the OFC is so successful.*
	Instructor's positive contributions to communication (2)	*S5: The instructor's guidance and his efforts to keep us engaged during the class hours were good.*
	Good communication with peers (3)	*S7: My friends and I often meet in private. We also sometimes exchange ideas before class hours … Communication between us is good for the most part.*
	Well communication with the instructor (4)	*S8: The instructor was explaining very well. He gave answers whenever we asked. He let us ask questions and express ourselves.*

Theme	Sub-theme (Frequency)	Sample expression
		There was no problem with his tutoring.
Learner autonomy	How the OFC process contributes to learning (5)	*S5: This process required higher-order thinking and the ability to synthesize the gathered information. That's why it contributed to my learning performance. I think I made progress concerning the course content.*
	Lack of practice (2)	*S7: I learned the instructional materials' characteristics theoretically. I wish I could develop instructional materials well. I may have some shortcomings when it comes to practice.*

When we consider the contents of Table 7, we can see under the Structure theme that the synchronous participants thought the course was well structured and it allowed them to express themselves. Their comments under the Dialogue theme were divided into four sub-themes. They first mentioned increased communication during the OFC; second, they mentioned how the instructor contributed positively to the communication process; third, they mentioned good communication among peers, and fourth, good communication with the instructor. As for Learner autonomy, they expressed the idea that the OFC positively contributes to learning and mentioned the lack of practice. The synchronous students focused on communication in the context of TD. Interaction with the instructional material was secondary and they did not say anything about it.

Synchronous Participants' Cognitive Load

Table 08

Synchronous Participants' CL Measurements

Students	Watching course videos	Class discussions	Evaluating instructional material	Writing a reflection paper
S2	5	6	6	2
S3	7	9	9	8
S5	7	9	9	7
S6	6	9	9	9
S7	6	8	6	7
S8	6	9	9	6
S9	8	8	9	9
Mean	6.43	8.29	8.14	6.86
Level	High	Very high	Very high	High

When we considered synchronous participants' CL levels on an activity basis, the lowest mean score belonged to the watching course videos stage, followed by the writing a reflection paper stage. The evaluating instructional material and class discussion stages are also at similar levels.

Irregular Participant's Transactional Distance Measurements

Table 09

Irregular Participant's TD Measurements

Students	m1	Level	m2	Level	m3	Level	m Mean	Level
S4	3.63	L	3.79	L	3.22	M	3.55	L

L: Low *M:* Medium *m:* Measurement *S:* Student

The early and midterm measurements for S4 are low. Her attendance had been irregular in the last month and her last measurement was medium.

Irregular Participant's Opinions Concerning Transactional Distance

Table 10 shows what S4 thought about the dimensions of TD.

Table 10.

Irregular Participant's Opinions

Theme	Sub-theme	Sample expression
Structure	Well structured	*S4: I was following the course videos sent on WhatsApp … I think it is reasonable to send course preparation videos, prepare the course with the videos, discuss the*

		video contents in class, and get feedback with the reflection paper.
Dialogue	Minimum level communication.	*S4: I prefer face-to-face communication…That's why my communication preference was at the minimum level. The communication process was not good for me, it's just who I am.*
	Communication possibilities offered by the OFC.	*S4: I think communication was high during the course, discussion process was active. There was preparation and the course progressed according to students' ideas.*
Learner autonomy	I am not satisfied with my learning performance.	*S4: I am not satisfied with my learning performance. I learned something when I attended the class hours. If I participate in a discussion actively, I do not forget what I learn. I got results when I participated during class hours.*

She found the course well structured. Under Dialogue, she mentioned that she had minimal communication and also the communication possibilities offered by the OFC. In terms of Learner autonomy, she said she was not satisfied with her learning performance.

Irregular Participant's Cognitive Load

Table 11

Irregular participant's CL measurements

Students	Watching course videos	Class discussions	Instructional material evaluations	Writing a reflection paper
S4	6	7	7	8
Level	Partly high	High	High	Very high

When we look at Table 11, the irregular participant felt the highest CL at the Writing a reflection paper stage and the lowest CL at the Watching course videos stage. She felt similar level CL at the Class discussions and Evaluating instructional material stages.

Discussion

Discussion on Transactional Distance

The student participating asynchronously in the OFC had similar TD measurements. All three measurements were low, so the results showed that the participant's TD perceptions were low. The interview collected evidence relating to the reasons for this situation. Under the Structure theme of TD, he thought it was well organized. Regarding the Dialogue theme of the TD, he expressed that he interacted well with his classmates, the instructor, and the learning content, meaning there was a positive interaction, therefore appropriate dialogue. Under Learner autonomy, he said there was a lot of external control and the OFC provided regular lesson-following mechanisms.

TD emphasizes psychological distance and in an asynchronous environment, TD level is based on the student's cognitive ability (Offir, Lev & Bezalel, 2008). If TD does not change and remains at the same level throughout the OFC process, it can be interpreted as indicative of a uniform learning process. In online courses, students prefer communicating with course content over communicating with teachers and other students (Ekwunife-Orakwue & Teng, 2014). The fact that the asynchronous student's TD levels remain the same, coupled with his thoughts concerning satisfaction with the process, can be considered as echoing this situation. The asynchronous student communicated with the course content and seemed satisfied with having little communication with the instructor and other students.

All seven students' TD measurements were low or very low. When we look at the Synchronous students' mean scores, we can see a steady decrease. The mean of the initial TD measurement scores was low, whereas the second and third TD measurement scores' means were very low. The interview results concerning the Structure theme of TD showed that the instruction process was well organized and the students could express themselves. Concerning the Dialogue theme of TD, the synchronous students mentioned increased communication, noting that the OFC process and the instructor contributed to this; they also mentioned good communication with their peers and the instructor. With respect to the Learner autonomy theme of the TD, the students touched on the contributions made by the OFC process to learning. Additionally, they reported acquiring the necessary theoretical knowledge but said they felt shortcomings when putting it into practice.

Positive results can be obtained in DE environments when there is sufficient communication (Offir, Lev & Bezalel, 2008). Therefore, action should be taken to establish student-student / student-teacher dialogue and

thus decrease the TD (Ekwunife-Orakwue & Teng, 2014). Yet, communication in a synchronous environment is not enough in itself to decrease the TD. The TD could decrease if shared ideas, feelings, and situations are ascribed a common meaning (Wengrowicz, 2014). It can therefore be expected that synchronous learning will improve the quality of learning by decreasing the TD (Offir, Lev & Bezalel, 2008).The TD measurements of the synchronous students' mean scores tend to decrease over time, suggesting that they are benefitting from the OFC process. Furthermore, according to So & Brush (2008), if activities in a social environment meet the students' learning expectations, they will be more satisfied with DE. The students who participated in the OFC process synchronously joined in the class discussions actively and exchanged ideas. Their perceptions of collaborative learning can therefore be expected to be high. The qualitative data gathered in this study fully support this.

The student who participated in the OFC process irregularly had low TD for the first and the second measurements and medium TD for the third measurement. Early on in the semester the student joined the class regularly her participation became irregular later. The interview results revealed that regarding the Structure theme of the TD she thought the OFC process was well organized. In terms of the Dialogue theme, she mentioned the communication opportunities offered by the OFC process. Additionally, she said that her preference for minimum communication was due to her personality. Regarding the Learner autonomy theme of TD, she used mentioned being dissatisfied with her learning performance.

Nowadays, although learning is facilitated by easy access to learning content due to the possibilities offered by the digital environment, TD is still a big disadvantage (Choudhury & Pattnaik, 2020). Studies have suggested making the environment as sociable as possible (Weidlich & Bastiaens, 2019) and increasing student-teacher interaction (Jaggars & Xu, 2016) to eliminate this disadvantage. Even if the aforementioned measures are attempted, there could still be some difficulties that are due to the students' individual characteristics. In learning environments such as FC, students can face what Rasheed, Kamsin, and Abdallah (2010) called Self-regulation Challenges and Students Isolation Challenges. These challenges can explain why the irregular participant's TD levels increased. In the qualitative interview, she expressed that she preferred minimum levels of communication and was not satisfied with her learning performance.

Discussion on Cognitive Load

The asynchronous student felt cognitive load at the evaluating instructional materials and writing a reflection paper stages. He felt no cognitive load for watching course videos and class discussions. The student who participated asynchronously felt the highest level of CL for evaluating instructional material. The student evaluated the instructional material individually and wrote a report about the instructional material. This activity embraces some cognitive activities at the analysis, synthesis, and evaluation levels. Many cognitive processes are taking place and it makes sense for him to feel CL at a high level. He felt partly high CL for writing a reflection paper. This stage is the last step for the students in any subject. Before this step, the asynchronous student watched course videos, class discussions, and instructional material evaluations. He then evaluated the instructional material and finally wrote his reflection paper. The student felt neither low nor high CL levels watching class discussions videos. At this stage, he followed the live course videos later and tried to understand his peers' opinions of the subject. He felt very low CL when watching course videos. At this stage, he prepared for class and acquired conceptual information. This is why he gave thought to the remembering and understanding levels of mental activities.

In the FC process, students' intrinsic cognitive loads decrease when they conduct pre-course activities such as watching video tutorials individually (Akkaraju, 2016) and their cognitive loads are not very high when they learn at their own pace (Zhang, Chen, Ge, Hung & Mei, 2019). Activities where the asynchronous student did not feel CL were the stages in which he prepared for the tasks he was going to fulfill and obtained information by watching videos. The activities where he felt CL also are the stages where he was productive. In other words, he had to use extraneous load and conduct germane processing more during these activities. Extraneous cognitive load can affect students' information construction processes (Chen, Fan & Fang, 2021) and can activate germane processing for processing the information deeply (Albus, Vogt & Seufert, 2021).

The synchronous students felt cognitive load at all stages of the OFC process. When we look at the CL mean scores of the synchronous students, we can see that they felt very high-level CL for Class discussions and Evaluating instructional material. The students were active during these steps of the instructional process and engaged in communication activities. They made preparations before these activities and exchanged information with each other during them. The felt high CL during the Watching course videos and Writing a reflection paper stages. They studied by themselves during these stages.

CL is related to mental effort (Chang & Yang, 2010) and can be described as the cognitive effort used to understand something and fulfill a task (Kolfschoten, Lukosch, Verbraeck, Valentin & de Vreede, 2010). But, if students take their time for the necessary mental processes, they can use their cognitive resources more effectively (Liao, Chen & Shih, 2019). In addition, the CL concept alone may not make sense for learning. To interpret learning efficiency, situations such as pre-class activities, post-class activities, self-paced video lectures versus face-to-face lectures (Abeysekera & Dawson, 2015) should be examined. The synchronous sessions of the FC entailed active and social learning activities, so they carried the risk of cognitive overload (de Leng & Pawelka, 2021). In this study, the synchronous students did their part in all steps of the process and focused on their learning in the OFC process. They studied individually when it was necessary to study individually, and actively joined in the discussions. They made a mental effort throughout.

It is thought that the reason for the synchronous students' high CL levels is the extraneous and germane cognitive loads. Even though it is thought that extraneous cognitive load may negatively affect the cognitive process (Cheng, Shen, Hung, Tsai, Lin & Hsu, 2021) when we consider the mental effort and task performance together, we can reach more accurate results regarding the cognitive costs of learning (Paas & Van Merriënboer, 1993) because extraneous load increasing germane processing can be the reason for the CL which in turn contributes positively to learning (Skulmowski & Xu, 2021). There is no clear evidence in this study to explain the high-level CL of the synchronous students. But it is thought that high CLs were for required learning, especially in the interactive stages of the OFC process.

The irregular student felt cognitive load at all stages of the OFC process. The irregular student felt the highest level CL at the Writing a reflection paper stage, this level being very high. Writing a reflection paper is the last activity for any subject. She must consider all of the past steps to accomplish this step and write a report that reflects her outcomes. The researchers believe that she had difficulty writing the reports because she participated irregularly. She had high levels of CL for class discussions and evaluating instructional material. These stages require preparation and discussions must be done with the other students. Lastly, she felt partly high CL at the watching course videos stage. At this stage, she acquired conceptual information to be prepared for the class.

There is a complex relationship between CL and learning performance. We cannot mention a direct relationship between the two variables. A high level of CL does not always result in high learning

performance. High learning performance is mostly related to high task performance (Wang, Fang & Gu, 2020). Students' CL may decrease when they interact, get feedback (Dinçer & Doğanay, 2017), and are scaffolded (Liao, Chen & Shih, 2019). At this point, students' approach to activities during instruction is also important and qualitative data are very valuable (Chang & Yang, 2010). The irregular student did not follow the course regularly, especially later on during the OFC process. In the interview held with her within the scope of TD, she said that her preference not to communicate much was due to her personal characteristics. The reason for the high level of TD during all steps of the OFC can be her communication choice.

The synchronous students' TD levels fell steadily. They felt very high-level CL at the instructional stages of synchronous Class discussions and Evaluating instructional material. When we consider these cases together, it can be said that the synchronous participation students internalized the course content in a social learning environment. It was observed that instead of executing DE traditionally, when we engaged the students and enriched the instruction process with FC pedagogy, the students focused on the lesson. In light of this, we suggest that DE events be conducted with pedagogies such as FC.

Thanks to the means provided by ICT, students who could not participate in the DE classes synchronously, were able to follow them from recorded class sessions later. This means that students who cannot participate in live classes and those who participate irregularly will not be left out of the instruction process; they can still benefit from it. The asynchronous student's TD levels did not change and his CL was not high. He was able to benefit from the process, albeit not to the same extent as the synchronous students. The irregular student's TD measurements were lower when she attended the course. The asynchronous student was able to benefit from the DE component of the OFC, which consisted of the combination of DE and FC. The irregular student also was able to benefit from the FC component. that the authors suggest using OFC instruction for asynchronous and irregular participants.

Conclusion and Recommendations

When we compare the students with three different features (asynchronous, synchronous & irregular) according to TD, we can see that asynchronous (but regular) student's TD levels did not change, the synchronous (regular) students' TD levels decreased consistently, and also the irregular student's TD levels increased when she did not attend class. The interviews conducted to gather in-depth data concerning TD revealed

that the students participated in the OFC process in different ways, and recounted similar and different cases with each other. All of them were in a consensus over the Structure theme of the TD and they thought that the OFC process was well constructed. In addition, the synchronous participants talked about the opportunity to express themselves. This was to be expected because the students tried to be active mainly during the live class hours. Concerning the Dialogue theme, the asynchronous and synchronous students mentioned the good communication established. But the irregular student expressed that she preferred to keep communication to a minimum. The synchronous participants and irregular participant agreed that the OFC process created opportunities for communication. As for the Learner autonomy theme, the asynchronous participant thought he was directed externally in the OFC. The synchronous participants thought that the OFC process contributed to learning, but felt a lack of practice. The irregular participant said she learned something when she participated in the classes.

Almost all students' CL measurements were high. The students' CL levels could be higher in the FC than in the traditional learning process. The reason for this is that FC challenges students more cognitively (Chen, Fan & Fang, 2021). The FC lets students prepare for the lesson in advance, thus decreasing their intrinsic cognitive load. They can use the extraneous cognitive load for intentional activities and will have opportunities to perform activities such as problem solving during class time (Akkaraju, 2016). There is no clear answer to the question "how much extraneous load is required for germane processing types?" (Skulmowski & Xu, 2022). But it is known that germane processing is important for the cognitive process of learning content (Chen, Fan & Fang, 2021). This study did not measure the CL types (extraneous, intrinsic, and germane). The results were interpreted according to the students' activities in the process. Similarly, other studies on CL do not mention the CL types either (Mutlu-Bayraktar, Cosgun & Altan, 2019). It is thought that new studies measuring CL types or obtaining qualitative data to determine the CL type may contribute to the literature and could allow for more accurate interpretation.

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