Interdisciplinary Cooperative Material Development in Teacher Education within the Context of Activity Theory

Özlem Baydaş [1]
Giresun University

Oğuzhan Sevim [2]
Atatürk University

Engin Kursun [3]
Atatürk University

Abstract

In the light of Activity Theory, this study aims to determine dynamics used by CEIT and Turkish teacher candidates in developing interdisciplinary cooperative materials; the role of these dynamics in the process of material development, the effect of this process on quality material design, and gains acquired by teacher candidates at the end of this process are also investigated. Effective communication was promoted through seminars, social networks, and weekly meeting hours with course instructors. A significant difference was found between materials constructed through interdisciplinary collaboration versus traditional methods. In addition, teacher candidates gained skills by studying in a different discipline.

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[1] Giresun University, Department of Computer Education & Instructional Technology ozlembaydas@hotmail.com
[2] Atatürk University, Department of Turkish Education oguzhan-sevim@windowslive.com
[3] Atatürk University, Department of Computer Education & Instructional Technology enginkursun@gmail.com

INTRODUCTION

It is crucial to use visual, auditory and animated materials in the construction of an effective and productive learning environment to support teaching. Diverse instruction materials increase retention by creating multiple learning environments (Akçay, Feyzioğlu, & Tüysüz, 2003; Mayer, 2002; Perkmen & Ozturk, 2009). Materials that are appropriate for subject and purpose meet learning objectives, make the subject dynamic, speed up learning by enhancing the learning process, broaden learners' areas of interest, make abstract phenomena concrete, and increase learner motivation (Demiralp, 2007; Kablan, Topan, & Erkan, 2013). In today's learning environments, with the advancement and expansion of technology, many materials have become digitized (Lawless & Pellegrino, 2007). However, developing these materials and using them effectively in classrooms requires the acquisition of some skills, such as interdisciplinary cooperative work.

During cooperative work, students have richer learning experiences and gain broader perspectives (Şahin, 2007). By creating positive dependence among group members, cooperative work paves the way for the fulfillment of individual responsibilities and intra-group assistance (Johnson & Johnson, 1999; Parveen, Mahmood, Mahmood, & Arif, 2010; Şimşek, Doymuş, Doğan, & Karaçöp, 2009; Uğurlu, 2010). Furthermore, group work should ensure that students are aware of individual responsibilities, are motivated, and have an opportunity to share their knowledge with others (Stenlev, 2003). Cooperative work offers platforms where students can freely express and discuss their creative ideas (Birişçi & Karal, 2011).

Other studies claim that group work makes it harder for learners to study individually and independently (Corliss, 2005; Panitz, 1997). Sevim (2011) found that when the conditions of positive dependence, common reward, face-to-face interaction, individual responsibility, social skills, and equal success opportunities are not ensured, problems may arise such as intra-group conflicts, poor time management, lack of personal responsibility, failure to fulfill duties, and domination of overbearing group members. The general qualities of cooperative work clearly make it ideal for interdisciplinary learning, but necessary conditions must be met. For example, in modern education, the integration of Information Technologies (IT) with learning environments is imperative, and interdisciplinary work plays an important role in supporting and improving education. Both IT and interdisciplinary cooperative work are regular and essential components of contemporary pre-service teacher education, highlighting the importance of successful communication and collaborative work by teacher candidates.

To integrate IT into courses, teachers must have technological and pedagogical skills secured via an effective and productive pre-service education, because a teacher's teaching methods depend on personal learning styles (Baki, 2006). These core skills should be taught at the undergraduate level. To this end, in 1997, the Instructional Technologies and Material Development course was added to the curriculum in faculties of education in Turkey (Goktas, Yildirim, & Yildirim, 2008). The course was two theoretical and two practical hours every week, and content was determined by the Council of Higher Education (CHE) as "qualities of various instructional technologies, their place and use in the learning process, developing instructional materials (worksheets, transparencies, slides, video/computer-based course material, etc.) through instructional technologies and evaluating materials of various qualities" (CHE, 1998, p. 27). A study conducted by the Ministry of National Education (MNE) Projects Coordination Center Directorate reported that current teacher computer education was not sufficient to prepare future teachers for the rapidly growing demands of integrating IT into education (MNE, 2007). The study also found that teachers had particular difficulty preparing and accessing education software. Now, in Turkey, during undergraduate studies, pre-service teachers attend the Department of Computer Education and Instructional Technology (CEIT). Originally designed to train computer teachers, this program now trains information technologies teachers who instruct other teachers about the integration

of IT and make an effort to popularize computer-assisted instruction (Karal & Timuçin, 2010). As CEIT teachers do not have information about all subject fields, the need for field specialists is obvious. Thus, CEIT teachers need to carry out hands-on practice in the field. However, during such practice, they experience many problems like reaching subject matter specialists. In order to overcome these problems, CEIT teacher candidates could conduct interdisciplinary cooperative work with teacher candidates from other departments of education faculties. In this way, both the CEIT teacher candidates' education and the field specialists' competencies in IT integration will improve.

The aim of this study is to analyze dynamics used by CEIT and Turkish teacher candidates (TTC) during interdisciplinary cooperative material development within the context of Activity Theory (AT). To this end, three research questions were investigated:

1. How did the dynamics analyzed within the context of AT affect the material development process?

2. What are the effects of the traditional and interdisciplinary cooperative material development process on quality material development?

3. What do the CEIT and TTC gain from the interdisciplinary cooperative material development process within the context of AT?

METHOD

AT can be used in design- or developmental-based research to discover practical applications, develop courses or learning systems, understand innovations, and adapt new technologies to education (Karakuş, 2013). In this study, AT was applied within a course design context.

Activity Theory

Innovations in instructional strategies have affected research methods in instructional design fields, leading to the development of contextual methods that are more suitable for illuminating rich, complex learning environments. On the other hand, moving beyond simply proving the effectiveness of technology in every environment, new studies in instructional technologies are now emphasizing the meaningful use of different technologies according to their users and contexts (Ross, Morrison, & Lowther, 2010). AT clarifies dynamics in learning environments and how these dynamics turn into learning outcomes. The fundamental element of AT is the source of the activity, and the goal for the shareholders of the activity is the "objective" (Engeström, 1987). Another important element is the "subject" that moves into action to achieve the objective. Around these two basic elements are the "instruments," "rules," "community," and "division of labor" that form the social texture and with which the subject interacts to achieve the objective. All components of AT were analyzed during the study process, and the system created is presented in Figure 1.
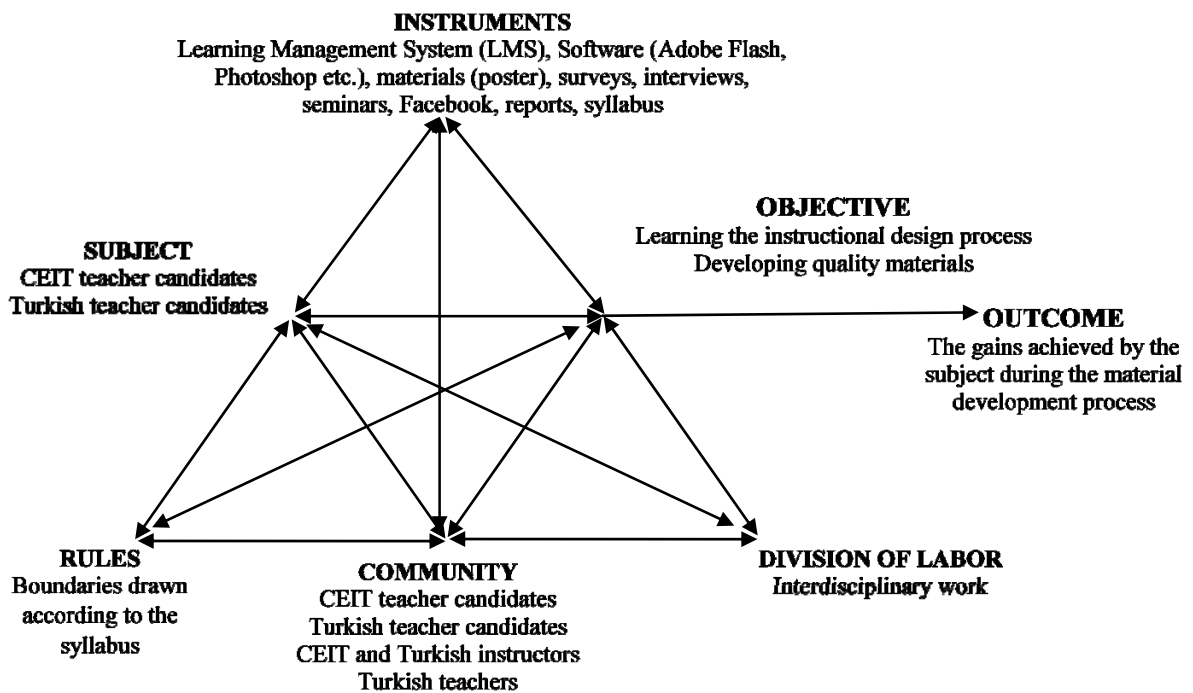
INSTRUMENTS
Learning Management System (LMS), Software (Adobe Flash,
Photoshop etc.), materials (poster), surveys, interviews,
seminars, Facebook, reports, syllabus

OBJECTIVE
Learning the instructional design process
Developing quality materials

SUBJECT
CEIT teacher candidates
Turkish teacher candidates

OUTCOME
The gains achieved by the
subject during the material
development process

RULES
Boundaries drawn
according to the
syllabus

COMMUNITY
CEIT teacher candidates
Turkish teacher candidates
CEIT and Turkish instructors
Turkish teachers

DIVISION OF LABOR
Interdisciplinary work

Figure 1: The System Developed According to Activity Theory for Interdisciplinary Cooperative Work.

Participants

The participants of the study were 41 daytime education students in their second year in the CEIT Department and 51 daytime education and 52 night time education second-year teacher candidates in the Turkish education department of a university in the eastern Anatolian region of Turkey.

Context

Division of labor: The study was conducted with three classes, one from CEIT and two from the Turkish education department. The experimental group consisted of daytime education CEIT students and nighttime education students from the Turkish education department, while the control group was daytime Turkish education department students. The experimental group divided themselves into cooperative work groups: the 41 CEIT teacher candidates formed 11 groups of 3 and 4, and the nighttime education students in the Turkish education department formed 11 corresponding groups. The control group formed 15 smaller groups.

CEIT teacher candidates acted as instructional design specialists during the material development process, while TTC acted as subject matter specialists. In the analysis stage of instructional design, the CEIT teacher candidates were actively involved in target group analysis, needs analysis, and environment analysis, while the TTC played an active role in conducting content analysis and determining instructional objectives. CEIT teacher candidates performed their duties to meet the technical needs in the material design and development process, while the TTC prepared the content and stories. All steps followed by the experimental group were also completed by the control group students. While the experimental group students, with technical and instructional design help from the CEIT students, approached the process from an interdisciplinary cooperative perspective, the control group students conducted the process traditionally. This change clearly demonstrates the fundamental difference between the experimental and control groups. The cooperative work process of the CEIT and Turkish education

students is summarized in Figure 2, while Figure 3 presents a comparison between the processes of the all study groups.
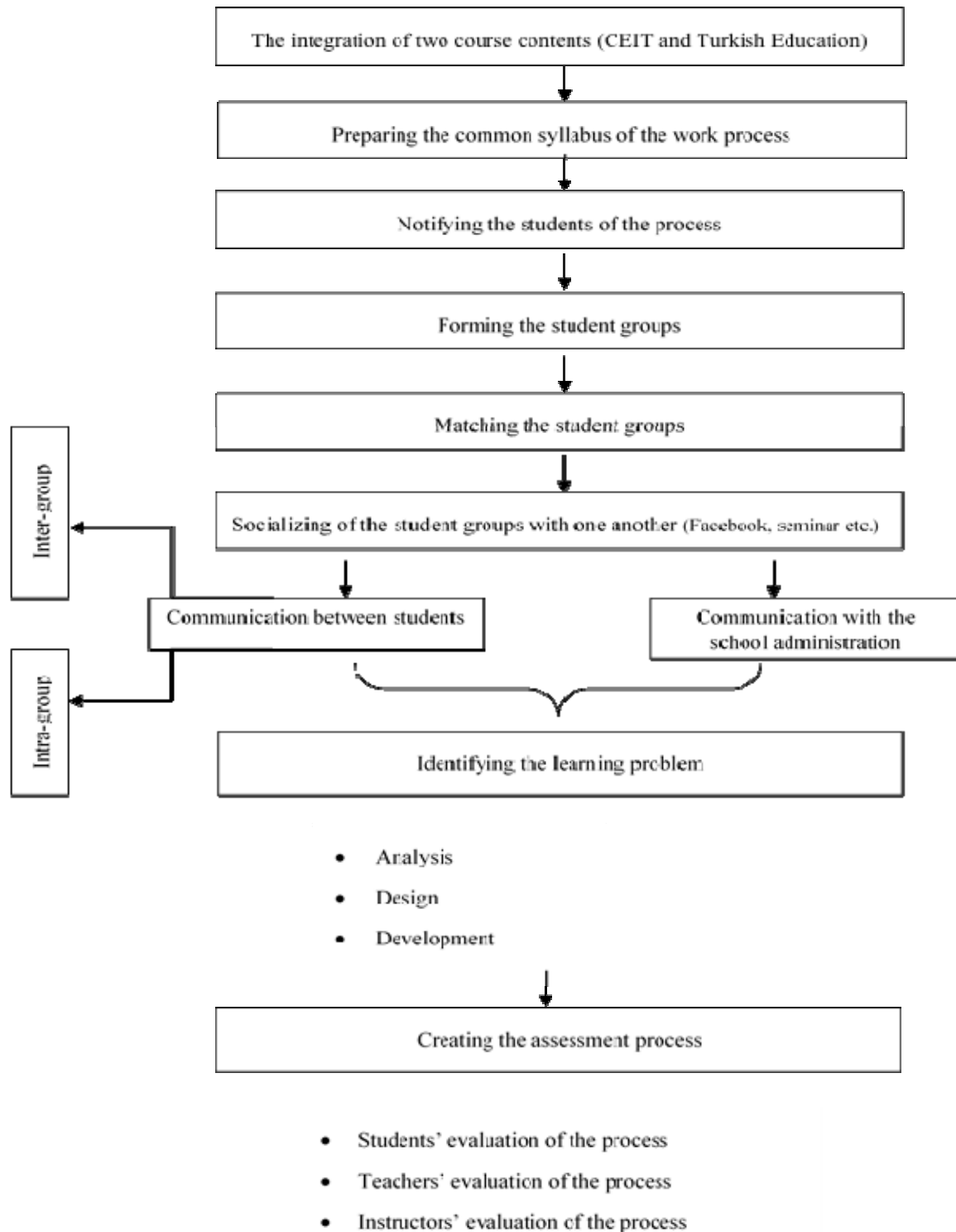

Figure 2: The flowchart of the Interdisciplinary Cooperative Work Process.

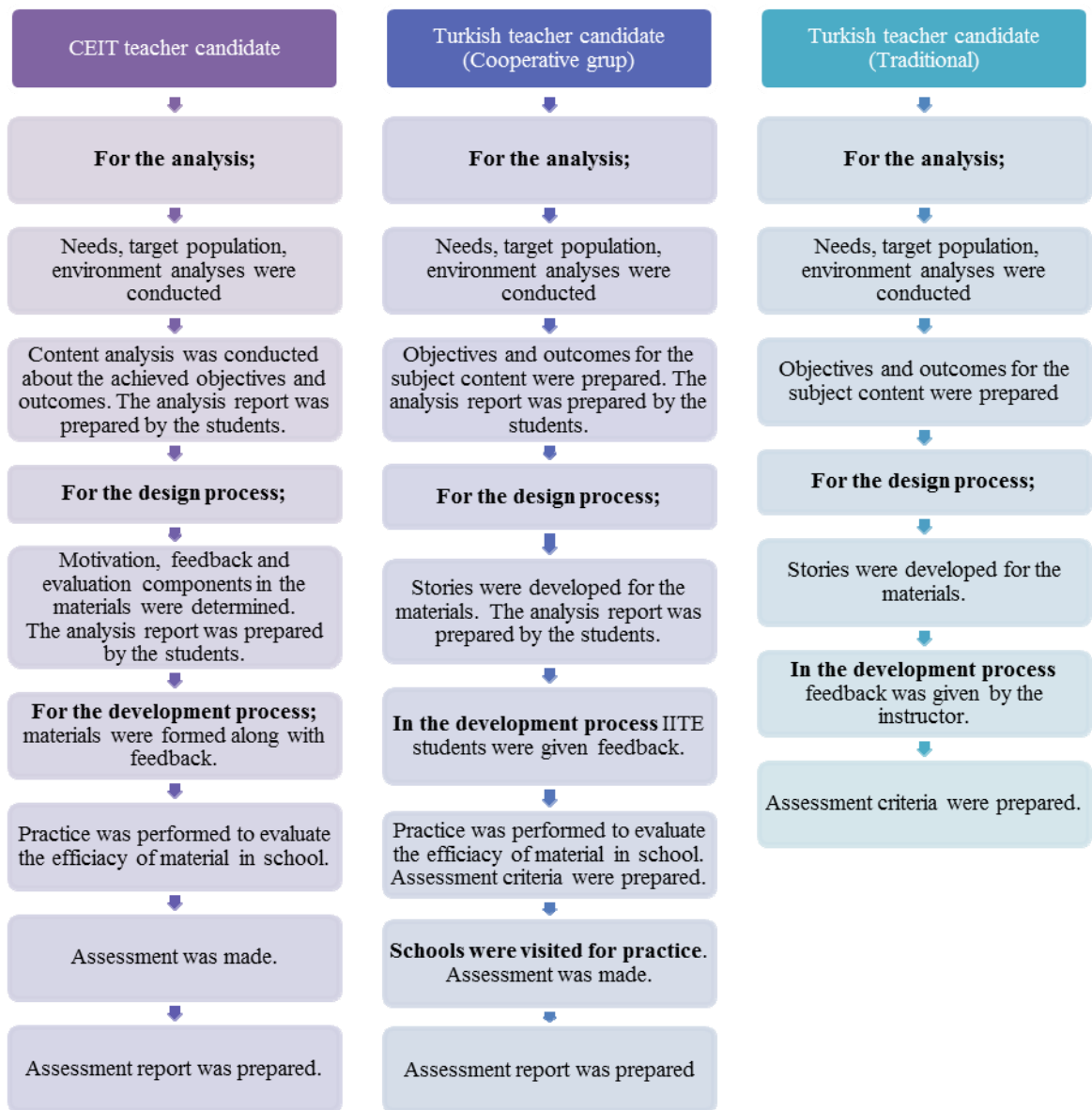| CEIT teacher candidate	Turkish teacher candidate (Cooperative grup)	Turkish teacher candidate (Traditional)
↓	↓	↓
For the analysis;	**For the analysis;**	**For the analysis;**
↓	↓	↓
Needs, target population, environment analyses were conducted	Needs, target population, environment analyses were conducted	Needs, target population, environment analyses were conducted
↓	↓	↓
Content analysis was conducted about the achieved objectives and outcomes. The analysis report was prepared by the students.	Objectives and outcomes for the subject content were prepared. The analysis report was prepared by the students.	Objectives and outcomes for the subject content were prepared
↓	↓	↓
For the design process;	**For the design process;**	**For the design process;**
↓	↓	↓
Motivation, feedback and evaluation components in the materials were determined. The analysis report was prepared by the students.	Stories were developed for the materials. The analysis report was prepared by the students.	Stories were developed for the materials.
↓	↓	↓
For the development process; materials were formed along with feedback.	**In the development process** IITE students were given feedback.	**In the development process** feedback was given by the instructor.
↓	↓	↓
Practice was performed to evaluate the efficiacy of material in school.	Practice was performed to evaluate the efficiacy of material in school. Assessment criteria were prepared.	Assessment criteria were prepared.
↓	↓	
Assessment was made.	**Schools were visited for practice.** Assessment was made.	
↓	↓	
Assessment report was prepared.	Assessment report was prepared	

Figure 3: Interdisciplinary Cooperative Work Process.

Rules: In this study, as part of the eighth grade Turkish course syllabus, the following topic subheadings under the general theme of Personal Development were distributed among the groups by drawing of lots: self-recognition, self-respect, personality types, empathy, responsibility, social development, positive thinking, choosing a profession, making a decision, success, entrepreneurship, and self-criticism. After determining subjects, the students were given the course syllabus. CEIT students were presented analysis, design, and assessment report templates and prepared and submitted reports throughout the semester.

During analysis, objectives for instruction were determined; needs, content, target population, and learning environment analyses were conducted; performance objectives and instructional strategies were prepared; and an action plan was created. These steps were followed by the design and development phase, when motivation, feedback, and assessment components were determined; instructional approaches, story sheets, and screen designs were created; and time tables and action plans were prepared.

All students were actively involved in the last step, practice and assessment. The methods used for assessment were prepared, followed by the assessment of the formation and the whole, as well as practice and revision. TTC contributed to the preparation of the assessment criteria. Analysis of a two-hour practice at a secondary school was carried out according to that criteria by all group members. Technical problems experienced during practice and not offering groups options beyond the theme of personal development proved to be the most significant limitations of the study.

Community: The community was composed of CEIT and TTC and Turkish teachers. The duties of the CEIT teacher candidates were detailed in the subject and rules sections above. The whole process was carried out by two CEIT instructors and one Turkish instructor. These instructors gave an average of five hours of feedback a week to group members. As subject field specialists, 11 Turkish secondary teachers lent support to the teacher candidates and played an active role in the assessment of the process and materials.

Instruments: The students used several instruments throughout the study. For example, Moodle, a Learning Management System (LMS), was used for the submission of reports and to present the syllabus and weekly assignments. The system recorded the submission date and time of reports. To notify students and instructors about problems, a Facebook group was created. Furthermore, to get the CEIT and Turkish teacher candidates to communicate socially, another Facebook group was formed, where an introductory seminar was delivered. Thanks to this group, the instructors were able to stay informed about the process. During analysis, the students benefited from data collection instruments including a specialist interview guide, a learning style questionnaire, and observation and achievement tests. In the design and development stages, materials were created in Adobe Flash. By taking the graphics and animation and multimedia applications course together with the CEIT teacher candidates in the same semester, they also provided technical contribution to the process.

For data collection, a material assessment form and interview guides were used. The assessment form was drawn from the literature, and its language was revised by a Turkish language expert. The form had 19 items worth 90 points scaled as very bad (1), bad (2), okay (3), good (4), and very good (5). The data collection instruments, sample set, material, and analysis methods are presented in accordance with the research questions in Table 1.

Table 1: Application of Data Collection Instruments for the Research Questions

Res. Q.	Data collection instrument	Data collection group	Data collection technique	Data analysis
1	Interview guide Seminar observations Facebook correspondence Reports	Turkish teacher candidate groups (n = 11) CEIT teacher candidate groups (n = 11)	Focus group interview Observation Document analysis	Content analysis
2	Material assessment form	CEIT instructors (n = 2) Turkish teachers (n = 2)	Material analysis (n = 26)	Mann-Whitney U Inter-rater reliability
3	Interview guide	Turkish teacher candidates (n = 11) CEIT teacher candidates (n = 11)	Focus group interview	Content analysis

Objective: The objective of the course was to gain instructional design skills and to learn how to develop

digital materials. The CEIT teacher candidates practiced effective digital material development by applying the instructional design process and working with field specialists. TTC contributed to the production of material designs appropriate for today's technologies, thus promoting IT integration.

The learning process is an integrated structure formed by the convergence of various dynamics. In order for this structure to be understood, each dynamic must be dealt with both in its own context and within the web of relationships that it forms with other dynamics. In this study, the interdisciplinary cooperative material development process is analyzed within the framework of AT, and dynamics such as instruments, subjects, rules, community, division of labor, objective, and outcome are analyzed in terms of their relationships with one another. This study focuses not only on the relationships among these dynamics but whether they have an effect on the quality of the material development process; gains acquired by the subjects are also presented within the AT context. The problem case is displayed in Figure 4.
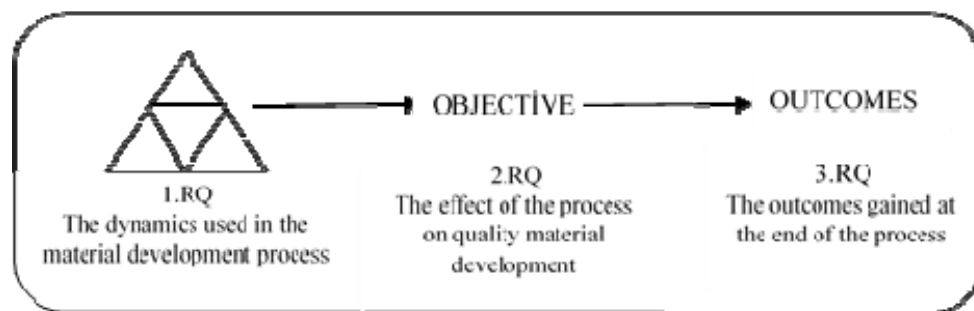

Figure 4: The problem case in the Context of Activity Theory.

FINDINGS

Activity Theory and the Material Development Process

The obtained data were analyzed within the framework of the dynamics affecting the interdisciplinary cooperative material development process, specifically subject–division of labor–instruments, community–rules–instruments, subjects–rules–instruments, and subjects–division of labor–rules.

Subject–Division of Labor–Instruments: To ensure division of labor and cooperation, a Facebook group and seminar presentation of instruments were prepared at the beginning of the process. Facebook helped the students get to know each other better and conduct information exchanges more quickly. Both students and instructors joined this group. The Facebook group had the following effects on the material design process:

- When students shared their opinions about the material development process, responses from other group members paved the way for assessment of the process. This interaction surely facilitated the constant workings of the assessment mechanism, which is absolutely crucial in material development.

- This group allowed the community members responsible for following the material development to monitor ongoing activity.

Another tool in the material development process, the seminar, enabled students to find answers to questions about the process. They were informed about how the process would be managed and the assignment of duties. Several prominent themes emerged from observation notes of the seminar conducted with the Turkish and CEIT department students.

- Maintaining the interdisciplinary work process: The process was explained in detail, including steps for students to sustain cooperation. The process time table, which had been prepared before the seminar, was discussed, and questions were answered.

- Group task assignments: The concept of interdisciplinary work and the students' responsibilities were explained. Detailed information about these responsibilities is in the theoretical framework section.

- Cooperative work groups: Students planned group meetings after the seminar, especially for material development. A work calendar was prepared for the cooperative work groups. Further, to ensure the division of labor between the Turkish and CEIT instructors, discussion hours were set up to critique the process.

- Supervision of the cooperative work groups: At the end of the seminar, it was announced that in the future, the cooperative work groups would be supervised by course instructors via Facebook messages and periodical meetings.

The seminar had two primary effects on the material development process:

- Students from the Turkish education and CEIT departments were able to meet, exchange ideas about the work calendar, and decide how to proceed in the future. They exchanged email addresses and phone numbers and selected a venue for their next meeting.

- Since responsibilities and expectations from both Turkish education and CEIT students were made so clear, related conflicts were prevented. At the end of the seminar, the work groups discussed the division of labor.

Community–Rules–Instruments: The community was made up of instructors, teacher candidates, and other shareholders at the school. The community, its rules, and the instruments enforcing these rules are summarized in Figure 5.
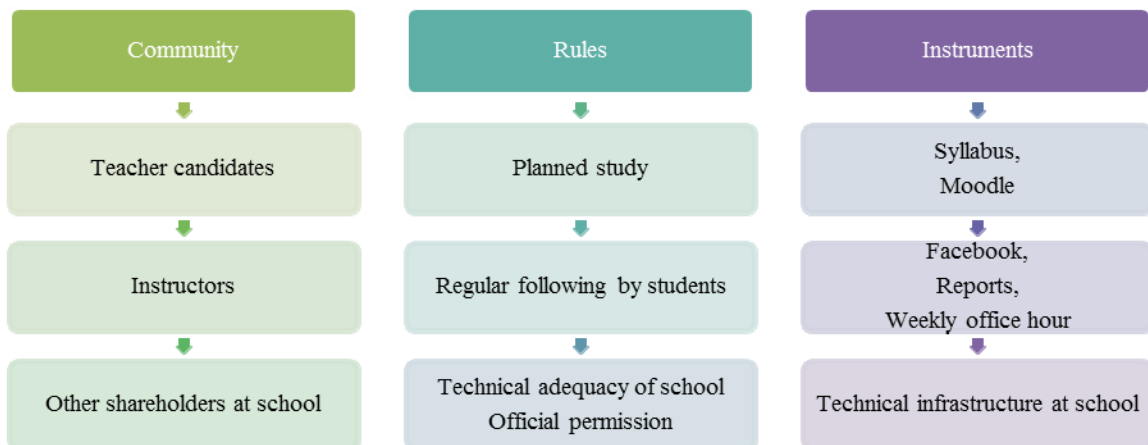

Figure 5: Rules to be followed by the community and instruments ensuring implementation.

One of the most crucial aspects of the material development process is instructors giving feedback when necessary. Tracking of the groups took place on Facebook, and feedback was provided via student reports and weekly office hours. One participant reflected:

Regarding our weekly work, both the CEIT department and our own department asked us to write a detailed report. To be able to write these reports, we needed to get together every week and work together. Some of our friends were only able to fulfill their course responsibilities with the push of the weekly checks conducted by the course instructors. (TTC_12)

Other shareholders at schools led to some problems for the cooperative work groups. During the attempted application of the materials to real school environments, some principals resisted granting permissions. Given the length of time required for official correspondence, some schools were dropped as practice schools in the study. One participant explained, "The principal of the school that we visited for pre-analysis told us that we could not enter the classes without permission and we could not talk to the students. Therefore, we had to find another school for the pre-analysis." (TTC_19).

Two primary reasons emerged explaining the lack of information technologies in learning environments: inadequacy of teachers' computer literacy skills and inadequacy of equipment in the primary school technology labs. Some teacher candidates were prevented from properly applying the instructional materials they developed due to poor infrastructure:

There was a smart board at the school where we went for practice. When we saw that, we decided to prepare a project in which we could use a smart board. But the teacher of the course told us that the smart board had been broken, and they had never used it. (TTC_8)

Another participant shared, "The computers at schools were really slow. It took them a very long time to open even a very simple program. This caused us to have even shorter time for our practice" (CEIT_25).

Subjects–Rules–Instruments: The syllabus and report submission deadlines were indicated on Moodle, the LMS. One participant explained:

I have learned how important it is to do planned work. Especially the completion of the whole process on time and submission of the reports in a timely manner on Moodle made me work to a plan. I have also learned that since you need others while working in a group, you need to work in a more planned way. (CEIT_28)

According to the teacher candidates, instructional technologies and the repetition of the presented information via report writing in the material development course ensured retention. One participant commented:

Every week we went to secondary schools for practice. After we were finished with the practice part, it came to reporting them. During such report-writing I was able to reflect on and better understand many issues that I hadn't been able to understand or relate to each other when I was at school. (TTC_18)

Subjects–Division of Labor–Rule: In the meetings, the teacher candidates stressed some factors that limited their cooperative work process, such as limited time and being unable to get together. One of the participants explained:

Our matching group in the CEIT department was a daytime education group, and we were a nighttime education group. We had great time difficulties in getting together. Meeting as a group was always a big problem. Besides, we were located on one campus, and they were on another. This distance between us was also very challenging. To overcome this, sometimes the CEIT group came to our faculty, and sometimes we went to their faculty. (TTC _31)

According to the teacher candidates, the size of the groups also limited their cooperative work. One of the participants complained:

> *The opposite group had four people, and ours had five. In our meetings, there were always some people from both groups who did not show up. And that led to problems in sharing the tasks. If there had been only two people in each group, it would have been much better. (TTC_5)*

Traditional and Interdisciplinary Cooperative Material Development

The cumulative grade point average of the two classes of TTC from the previous semester were compared, and no difference was found ($t = .553$, $p > .05$). Therefore, these two groups had equal levels in terms of material development capabilities. All resulting materials were scored by two Turkish education instructors and one Turkish teacher according to the material evaluation form. These scores were averaged by one Turkish education instructor and two Turkish teachers, and the two groups were comparatively analyzed. Due to the low number of created materials, a non-parametric test, the Mann-Whitney U test, was applied. Between the materials developed traditionally and the materials developed in cooperation with CEIT, a difference in favor of the latter was found ($U = 15.000$, $p < .05$). The details are shown in Table 2.

Table 2: Differences between Traditional Materials and Materials Developed with CEIT Collaboration

Groups	N	M	S.T	S.O	U	z	P
Traditional material development	15	51.33	132	8.8			
Cooperative material development with CEIT candidates	11	72.63	219	19.9	12.000	-3.66	.000

Inter-rater reliability was confirmed across the 26 instructional materials to increase reliability among scores given by the three Turkish field specialists. The correlations, which were high, are shown in Table 3, demonstrating that the scores are reliable.

Table 3: Inter-rater Reliability Coefficients

	Instructor_1	Instructor_2	Teacher_3
Instructor_1	1		
Instructor_2	.978[**]	1	
Teacher_3	.983[**]	.981[**]	1

[**]Correlation is significant at 0.01 (2-tailed).

Outcomes Acquired by CEIT and Turkish Teacher Candidates

In order to determine the common outcomes gained by the CEIT and TTC in the interdisciplinary cooperative material development process, interview results were coded and categorized. Results are presented in Table 4.

Table 4: Outcomes gained by teacher candidates

	Contribution	Turkish	CEIT
Common Outcomes	Acquisition of the skill of conducting a collaborative project with a different discipline	7	10
	Observation of the real learning environment	6	8
	Acquisition of the research-conducting skill	6	4
	Learning how to write a scientific report	4	5
	Overcoming biases against projects or group works	4	5
	Increasing the positive attitude towards teaching profession	2	4
	Understanding the importance of instruction design	4	1
	Gaining social skills	3	1
	Developing a sense of responsibility	1	1
TTC outcomes	Understanding the effect of computer-assisted materials on learning	6	-
	Deeper understanding of the principles and concepts of Turkish instruction	5	-
	Learning the principles of digital material preparation	3	-
	Acquisition of the strategic decision-making skill	2	-
CEIT outcomes	Gaining awareness that content will be provided by field specialists	-	8
	Gaining experience thanks to the detailed execution of the instructional design process	-	8
	Learning the official procedures of the MNE	-	4
	Gaining awareness that field specialists are needed in the evaluation process	-	2
	Equipping the teacher candidate with self-confidence	-	1

Common outcomes: The primary points emphasized by all teacher candidates were the acquisition of collaborative skills and the observation of real learning environments. One participant indicated:

> *I never thought that we could work on a common project with another department. I didn't believe that this kind of a process would work. I never imagined that such a process would end up successfully. But we had a really good project period with our friends from the CEIT Department. We produced effective materials as we had designed. If you ask me what I gained from this process, I can say that we gained the skill of carrying out a common project with a different discipline. (TTC _2).*

Because the teacher candidates had no prior research practice, gaining research skills and learning how to write reports were important. One teacher candidate expressed:

> *To me, one of the biggest gains from our work with the CEIT Department is our learning to do research. I was in my second year but I didn't know where to start research. I have learned where to begin with research in theoretical courses. With our practices, what I have learned has become more permanent. (TTC _25)*

> *Another student revealed, "In the beginning, I saw report writing as unnecessary, but now I have learned how important report writing is. We did not write any such comprehensive reports previously. We used scientific language" (TTC_32).*

At the beginning of the application, the students had biased feelings towards interdisciplinary cooperative work. The interviews conducted at the end of the study showed that these biases were significant factors in the effective application of the process. However, after considering both researcher observations and participant opinions, in the later stages of the process, these biases weakened and, in some groups, reversed. Participants explained:

When you told us that we were going to work on a project with the CEIT Department, I never thought that this (work) could be finalized. I thought that both the other group and our group would cause some problems. But when I look at it today, there is actually a material that we have produced together. (TTC_28)

Outcomes gained by Turkish teacher candidates: The most commonly mentioned outcomes for the TTC was becoming aware of the effect of computer-assisted materials on learning and learning the principles of digital material preparation. Two of them indicated:

My biggest gain from this process was my deep learning about instructional material design and my application of what I learned, because during this work we learned all steps of instructional material design and applied each of them hands-on, in person. (TTC _26)

In my observations during our practice classes, I saw how eager the students were to participate in these practices, how they competed to do the activities and how they kept their focus constantly on the topic at hand. Indeed, digital materials make our job a lot easier. (TTC _38)

TTC also mentioned learning principles and concepts like documenting outcomes as a gain:

To be able to design the material, the objectives must be determined. In the past I didn't exactly know what an objective was. As the process progressed, I realized that the objectives that the CEIT Department wanted from us were actually the outcomes in our own courses. (TTC _20)

Outcomes gained by CEIT teacher candidates: The CEIT teacher candidates realized the importance of working with a field specialist in accessing course content, as well as the detailed application of the instructional design process. One teacher candidate stated:

If it had not been for the TTC, first we would have had a problem finding the content. This gained us time and allowed us to have better results by getting their opinions as well. Besides, by drawing them on paper, the TTC gave us ideas on how the applications during the material development would have to be done. After the application, we showed them to our friends and elicited their opinions. They also came to the application part. We did the application together as well, so they gave us support in everything. (CEIT_8)

DISCUSSION

Modern attempts to integrate information technologies with learning environments often capture specialists' and researchers' attentions. Sadaf, Newby, and Ertmer (2012) stated that teacher candidates are particularly enthusiastic about using IT in their future classes, but they do not know how to integrate it into their teaching. Therefore, effective integration of technology depends not on experience using it but a thorough knowledge of methods (Dexter, Doering, & Riedel, 2006). On the other hand, considering that IT is constantly developing and changing, related skills have recently expanded to include pedagogical skills used to solve learning or performance problems, rather than just the ability to use software, projectors, or computers (Reiser & Dempsay, 2002). Consequently, equipping teachers with technological competencies must be viewed multi-dimensionally (Varank, 2009). In their preservice period, teacher candidates need to be equipped with the relevant technological and pedagogical skills required to present their subjects more effectively by using information technologies (Kay, 2006; Koehler and Mishra, 2008; Sutton, 2011).

Dynamics Affecting the Interdisciplinary Cooperative Material Development Process

In this study, dynamics affecting the interdisciplinary cooperative material development process and the web of relationships among these dynamics were analyzed in the light of AT. According to results, creating an effective cooperative work and communication environment is an important factor in quality material development. One key dynamic is division of labor. Since interdisciplinary work involves a process where many fields come together, the division of labor has to be effectively and clearly determined at the beginning. In addition, another important component in effective cooperation is effective communication. Thus, one of the dynamic networks of the material development process is constituted by the interplay among the subjects, division of labor, and instruments, emphasizing the importance of various communication channels. In the division of labor among the CEIT and Turkish education teacher candidates, communication instruments such as a seminar, social network, and LMS were used. Many questions were answered via the seminar at the beginning of the process, and the Facebook group allowed instructors and participants to track and monitor ongoing progress. Periodical tracking and feedback provided during the weekly office hours also played a significant role. Besides being a forum to present products to shareholders, the seminar and social network were found to have a positive impact on communication among students, preventing potential conflicts (Jones, Blackey, Fitzgibbon, & Chew, 2010; McCarthy, 2010). In addition, the LMS and requirement to prepare a report for each step encouraged teacher candidates to do planned, systematic work.

However, the effective communication between the teacher candidates and instructors could not be replicated with other school shareholders, who were the third element in the community dynamic. During the attempted real learning environment application of the instruction materials developed by the CEIT and Turkish teacher candidates, some school principals refused to grant official access permissions. Furthermore, opposing schedules in the cooperative groups made it difficult to arrange convenient times to work together; some groups were also considered too crowded for effective inter-group communication. All these limitations have been determined as preventive factors in parallel research (Okojie, Olinzock and Okojie-Boulder, 2006; Su, 2009).

Quality Material Development

The quality difference was also analyzed between the materials prepared in the two groups, and the materials developed through the interdisciplinary cooperative method were found to be more interesting, entertaining, time-saving, and likely to ensure learning retention. Instructional technologies are not only platforms of pure technical information but have complex structures that include pedagogical content (Koehler, Mishra, & Yahya, 2007), as demonstrated by the cooperative work of the CEIT and Turkish teacher candidates during the material development process. However technically advanced instruction software might be, if it fails to deliver the desired learning outcome, it is educationally poor. Considering Turkish course expectations, the materials developed jointly by the CEIT and Turkish teacher candidates were successful both technically and in effectively accomplishing desired learning outcomes.

Outcomes Gained by Participants

Findings regarding outcomes gained by the CEIT and Turkish teacher candidates during the interdisciplinary cooperative material development process were discussed from the perspective of AT. According to the teacher candidates, one important outcome was the skill of creating a project with someone in a different field. The application of their cooperatively developed instruction materials at schools changed their perceptions about authentic learning environments. The teacher candidates realized that an authentic learning environment cannot be organized by instructional designs simply drafted at an office desk or in a lab; an effective instructional design can only be evaluated as such after it

is applied in a real learning environment (Ertmer, 2005; Kopcha, 2012; Sugar, 2005). Considering the general objectives of instructional technologies and the material development course, the interdisciplinary cooperative material development work made a contribution to both Turkish education and the basic principles of the CEIT program. This finding meets the expectation that designed works in a technology integration process must be in line with their basic principles (Bucci, Copenhaver, Lehman, & O'Brien, 2003).

From the CEIT candidates' perspectives, findings indicated that in the process of material development, they need to receive assistance from and collaborate with field specialists. Furthermore, the hands-on application of the instructional design process significantly contributed to their teaching experiences. Learning to write reports also came to the fore as an effective gain. The findings demonstrated more specific outcomes for the TTC, who observed the IT-supported materials' effects on learning, realized the importance of instructional design in teaching, and mastered Turkish teaching principles and concepts. Finally, participating in interdisciplinary cooperative work allowed the teacher candidates to reflect on the process by using the knowledge and skills that they gained from a different discipline and thus contributed to making the process a meaningful experience (Yıldırım, 1996).

Conclusion and Suggestions

In this study, the interdisciplinary cooperative work process was analyzed in light of AT, and the instruction materials cooperatively developed by CEIT and Turkish teacher candidates were found to be more instructionally effective than the traditional materials developed by the control group. Within the framework of AT and based on current findings, the following suggestions can be made:

- As interdisciplinary work becomes increasingly important, preservice teacher education must be taken into account. Therefore, teacher candidates must be exposed to learning environments in which they conduct interdisciplinary cooperative work.

- Due to the convergence of different disciplines, some communication problems may arise. Hence, it is vital to monitor the communication process. The process can be managed by using communication channels such as weekly office hours, seminars, and social networks, as was the case in this study.

- The dynamics of the interdisciplinary cooperative work process must be analyzed well at the beginning of the process. Clearly delineating the rules and designating the division of labor will be effective in preventing communication problems later.

- Securing official permission from the administration proved to be a significant challenge in this study. To avoid similar issues, all permission procedures must be solved at the outset.

- Problems tackled by interdisciplinary work groups must be identified not by instructors but by teacher candidates themselves in an authentic learning environment, ensuring a faster process adoption.

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