Establishing a Multidimensional Interaction in Science Instruction: Usage of Mobile Technology

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ABSTRACT
The aim of this study is to examine the effect of mobile technology use in university science instruction on students' academic achievement and self-regulation skills. An experimental study is conducted to test the use of mobile in-class interaction system (M-CIS) and to determine the change in students' academic achievement and self-regulation skills in a science class. Motivated Strategies for Learning Questionnaires, Academic Achievement Tests and Semi-structured interview forms are used as data collection instruments. In the data analysis process, descriptive statistics, covariance analysis (ANCOVA), Mann- Whitney U test and content analysis are used. At the end of the study, it is found that the use of mobile technology in science instruction sustained to be effective in increasing students' academic achievement. Besides, the M-CIS provided significant changes in teaching, instruction and learning atmosphere, as well as students' and teachers' affective outcomes.
Keywords: science instruction, self-regulation, academic achievement, mobile technology

INTRODUCTION
In today's world, technological developments are quite fast and science education forms the basis for the success of countries in competitive research and development activities (Singer, Hilton and Schweingruber, 2006). Skills that are acquired with science education make great contributions to raising students who can correspond to the requirements of the era (Abd-El-Khalick *et al.*, 2004). Science laboratories, in which experiments are done actively, are very important in developing these skills. Students acquire various skills while structuring their knowledge during activities in laboratories (Hofstein, 2004).

In learning science, laboratories help children carry out practices through experimental researches or make interpretations about the issues they learn in theoretical lessons. Making activities only with the equipments in laboratories is not sufficient for learning; students should also be able to make operations mentally by producing ideas (Berg, 1997). Students in the process of research-analyze, asks questions, make analyzes, make inferences and report the result. While doing all these, necessities for obtaining feedback about metacognitional processes occur (Larson and Keiper, 2007). Obtained feedbacks can enable students make assessments about personal learning process besides providing opportunity to constantly direct student interest towards lessons. With this proper intervention, student gets the opportunity to proceed in research activities (Flick, 1993). Obtained feedbacks also ensure student make cognitive arrangements (Lee, Lim and Grabowski, 2010).

In order to present feedback to student, firstly assessment and evaluation should be carried out during learning process.

Formative assessment, which is one of the significant tools in ensuring feedback to student, is the assessment of students about their learning during a duty or activity. These assessments aren't carried out for determining success, failure or grading a student. Formative feedback presented to student after assessment gives students the opportunity to construct his personal learning (Irons, 2007).

Mazur (1997) mentions three different methods about taking feedback from students in classroom environment. *Show of hands:* In this method, students raise hands or use answer cards marked between A-F while answering a question. *Scanning forms:* Students write their answer and self-confidence levels to the questions in these forms. Forms are individually filled in twice; one before discussing with the friend group, one after making a discussion. In this way, understanding level of students, development, and efficiency of peer instruction is evaluated. *Handheld computers*: In this method, which is called ClassTalk, technological devices such as portable laptops, handheld computers, special calculators with graphic function are used and students are required to answer Concept Tests. Teacher can project the answers in his/her computer to the board when he wants. In this method, answers are given individually and it is possible to give individual training in big classes. In order to make individual training, it is necessary to give students the opportunity to organize feedback he needs. On the other hand, according to the feedbacks obtained by teacher, the opportunity to organize personal learning strategy and a better instruction opportunity should be ensured. Establishing an interactive classroom environment is especially important for teachers in order to make necessary organizations in instruction strategies according to student needs, and for students in order to make self-regulation in their individual learning.

As can be seen in Figure 1, an interactive classroom environment, structured by using M-CIS, gives more opportunity to have interaction among students than a normal classroom environment. In this interaction, teacher can have information about each student's learning and give personal feedback. Similarly, students can have feedback they need in the process of learning. It is also possible to establish a multidimensional discussion environment when needed. Interactive classroom environment in which multidimensional feedback correction is possible, also provides saving of time. Feedback correction in short time and multidimensional interaction present student the opportunity to learn individually besides giving teacher the chance to assess the instruction he carries out.

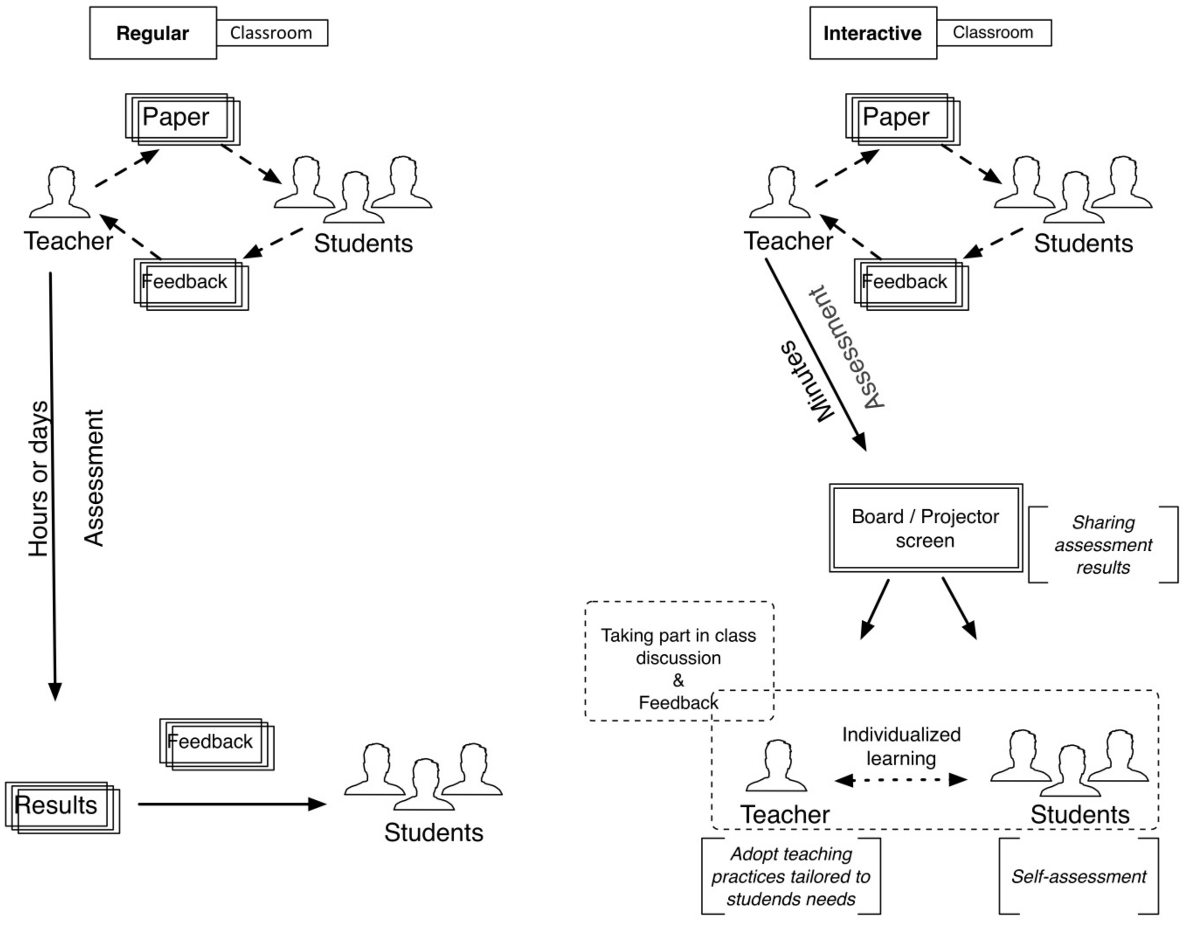

Figure 1. Traditional classroom environment and interactive classroom environment

M-CIS is developed in order to make contribution to establish an interactive classroom environment as it can be used as a learning tool in science laboratories and it has significant technologic substructure. While designing the system, ADDIE Model, which is one of the instructional design models, is used as the basis. It has five components. First, analysis phase: seek answers to a variety of questions to determine the components. Second, design phase: manage all of systematic method. Third, development phase: create instructional material. Fourth, implementation phase: an implementation plan is developed. Fifth, evaluation phase: determines the quality and effectiveness of the instructional design (Jones and Davis, 2011).

A preliminary survey was carried out about student expectations and present technologic sub-structure sufficiency before designing M-CIS (Yılmaz and Sanalan, 2011, Yılmaz, Sanalan and Koç, 2009). According to the obtained results, it was seen that students had positive thoughts about the use of mobile devices in Science classes and most of them wanted to use devices in laboratory lessons.

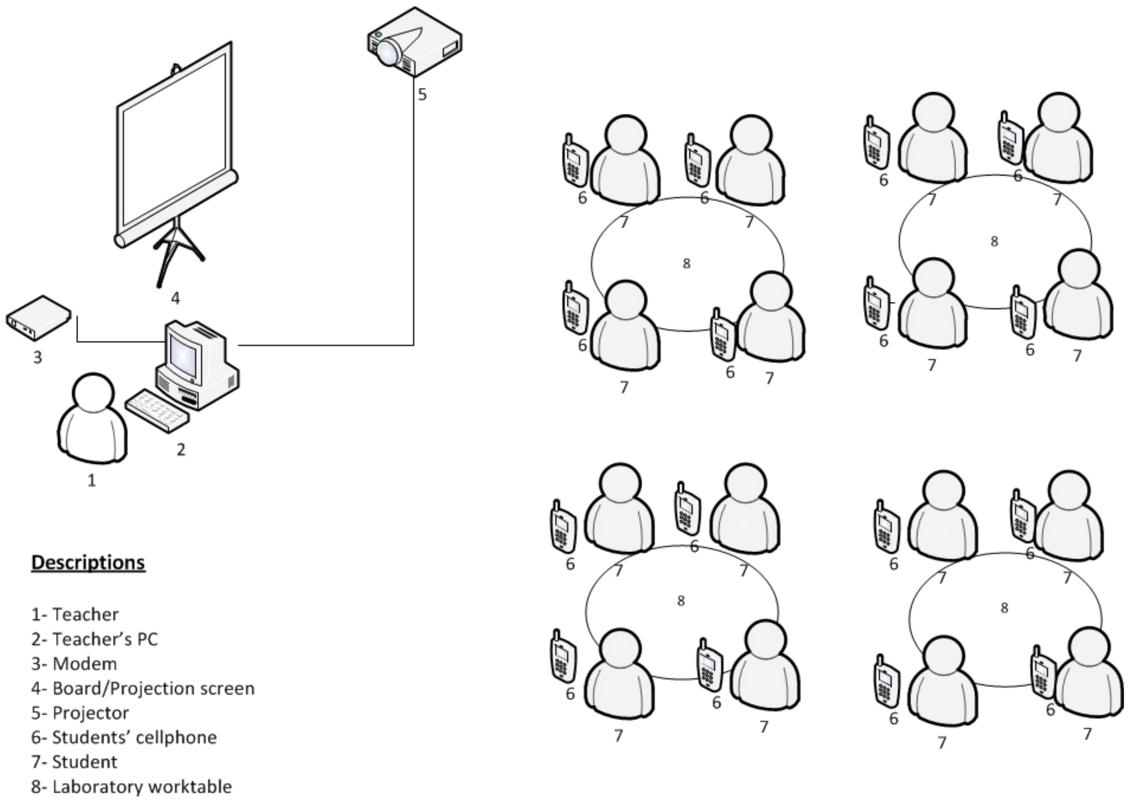

Figure 2. Laboratory classroom environment structured by using M-CIS

As can be seen in Figure 2, students sit in groups (8). While making an experiment practice, students in a group work together (7). In order to assess or direct activities, teacher (1) sends the question he prepares in his computer (2) to students by using the system. According to the questions or directions in their cell phone (6), students make studies in the group for finding the solution. They also use cell phones in order to answer the question. Answers of student groups appear in the computer of teacher. Teacher has the chance to assess experiment practices and student learning. If he wants, he can project these results on the board (4) with the help of a projector (5). In this way, correct or incorrect answers can be discussed and assessed in classroom environment. Results projected on the board give students the opportunity to see correct or incorrect answers. Students interact with the group members, they can get feedback from teacher when they need and interact with the members of other groups. Teacher can use the system through his cell phone; in this way, he can also present guidance during experiment by walking around the classroom. All of this system connection is ensured by internet (3). Data input-output and recording is made through a server.

M-CIS is an interclass interaction system. This system is basically similar to systems such as student response system (Griffin and Kopanski, 1988), listener response system (Ureel and Israels, 2013). Student response system and listener response system are common synonyms with 'classroom communication system', 'audience response system', 'voting machine', and, colloquially, 'clickers' system (Beatty and Gerace, 2009). In the researches about student response system, which has been used, synonym names with similar mobile technology, for different purposes in education.

Classroom response system (CRS), a kind of mobile technology which is designed to support classroom communication, interactions in university classrooms is evaluated by Fies and Marshall (2008). They have explored the answer to that question 'What are the motivations in the decision to use a CRS?' First, checking attendance: 'system made it easier to keep track whether students were in classes. Second, pacing a lecture: 'system provides a planned or spontaneous switch lecture's prevalent one-way flow of information (instructor to student) to a segment where student'. Third, formative assessment: 'CRS as a tool to gauge understanding on the classroom level'. Fourth, formal assessment: 'collecting scores and to automatically logging'. Fifth, enhancing peer instruction: 'fostering group interaction'. Sixth, scaffolding meaning-making: 'providing learners as a guidance when they needed it'. Seventh, just-in-time-teaching: 'identifying the teachable moment within a lesson'. According to Yarnall, Shechtman and Penuel (2006), using handheld computers, to support improved classroom assessment in science, changed in teachers' goals for assessment. They said that 'Teachers became more interested in assessment for learning, and assessment became more important to them in the context of their science teaching.' Another study was done by Brady, Seli, & Rosenthal (2013). They found that clicker use produced significantly higher performance outcomes on undergraduate educational psychology course. Kay & LeSage (2009) have reviewed of the literature about benefit and challenges of using audience response systems (ARSs). They found that ARSs increases in 'attendance, attention levels, participation and engagement' in the classroom environment, increases 'interaction, discussion, contingent teaching, quality of learning, learning performance' in learning, and supplies 'feedback, normative, formative' assessment. Studies on the issue showed that mobile technology was effective on learning and instruction.

The goal of this research is to analyze the effect of mobile technology use level in university education level science instruction on student self-regulation abilities and academic success. In the preliminary survey about the use of mobile technology in Science education, it was determined that the mobile technology that is proper to be used in the study is cell phone. In this preliminary survey, it was also determined that the designed M-CIS is proper for using in science laboratories actively (Yılmaz and Sanalan, 2011) On the other hand, in order to assess the contribution of the system to science education, teachers used the system in Physics, Chemistry and Biology classes. Student and teacher ideas about establishing interactive classroom environment were taken into consideration and usability of mobile technologies in science education was researched.

For this purpose, this study started with the question of "What is the effect level of the use of mobile technology in establishing a classroom environment that improves student success and self-regulation abilities?" These sub-research questions, which reflect the expectation of the research, were attempted to be answered

1. Does the use of M-CIS (Mobile classroom interaction system) increase student academic success in university science education level?

2. What is the effect of the use of M-CIS in university science education on student self-regulation abilities?

3. What are the views of science teachers and students about the use of M-CIS?

METHOD

In this study, quantitative and qualitative research methods are used depending on the researched questions. Quantitative method is used to determine the change in students' academic achievement and self- regulation skills in science instruction. Motivated Strategies for Learning Questionnaires, Academic Achievement Tests are used as data collection instruments. Qualitative method is used to get views of science teachers and students about the use of M-CIS. Semi-structured interview forms are used as data collection instruments.

Sample

The study was carried out in a mid-size Education Faculty in Eastern Anatolia. The research included a total of 164 students, chosen from 558 students in the Department of Science Instruction at the 2nd grade; the average age of students was 20.01. In the planning process made for the use of prepared system, as it was determined that the most proper laboratory class was General Biology Laboratory class when class teacher and the state of student system use was taken into consideration, 2nd grade students were chosen. 66.5% of students of General Biology Laboratory class were female while 33.5% were male. Besides students, three volunteer academicians used the system in their class (Physics, Chemistry, and Biology). During an academic semester, students used Mobile Interclass Interaction System regularly, generally towards the end of lessons.

Data collection tools

In order to gather data for the study, Motivated Strategies for Learning Questionnaire, academic success test, structured interview form G1 and G2 (G1 for students, G2 for teacher) were used.

Motivated strategies for learning questionnaire (MSLQ)

The scale is developed by Pintrich and Groot (1990); it is prepared in order to determine the strategies and motivational tendencies used by students for learning. Üredi (2005) adapted the scale to Turkish with the name of *Öğrenmeye İlişkin Motivasyonel Stratejiler Ölçeği (*ÖİMSÖ); it has two sub-scales in self-regulation strategies dimension as cognitive strategy use (13 items) and self-regulation (9 items); 3 sub-scales in motivational beliefs dimension as self-sufficiency (9 items), intrinsic value (9 items) and test anxiety (4 items). Grading used in the assessment instrument was 7 points likert type scale organized between "completely proper for me" and "completely not proper for me". It was determined that the Cronbach Alpha value of scales' sub-scales was 0.84 for self-regulation; 0.92 for self-sufficiency; 0.88 for intrinsic value and 0.81 for test anxiety scale (Üredi, 2005). In another study in which the survey was used, it was determined that internal consistency coefficient (Cronbach Alpha) was 0.68 (Akkaya, 2012).

When the reliability-validity of the scale was analyzed for this study, it was determined that test anxiety sub factor of the scale wasn't functioning. After the statistical analysis, the scale was assessed with different sub-factors. Cronbach alpha values of the sub-scale were determined to be 0.84 for cognitive strategy scale; 0.81 for self-regulation; 0.86 for self-sufficiency; 0.82 for intrinsic value. Internal consistency coefficient of the scale which has four sub-scales and 35 items was calculated to be $\alpha = 0.92$.

Academic success test
Validity: Curriculum of General Biology Laboratory is viewed with course instructor to prepare the indicator chart. Question pool is prepared from Secondary School Student Selection and Placement Exam, Student Placement Exam, and Open High School Exam. Two lecturers' views are used to check relevance of questions and indicator chart based on General Biology Laboratory curriculum. For pilot study, 37 questions achievement test is prepared.

Reliability: After the reliability analysis for the success test including a total of 30 items, it was determined that alpha internal consistency coefficient was 0.62. The value of 0.50 and over is accepted to be reliable for tests including few items. It is expected that reliability coefficient is 0.80 or over for tests including fifteen or more items (Şencan, 2005). So, it was determined that success test used in the research was reliable.

Student interview form (G1)
This form is structured interview form prepared for obtaining the views of students about M-CIS. There were 9 questions in the form prepared for determining difficulties experienced by students while using M-CIS, eases ensured by the system, the points that are beneficial for the learning process of students and friends.

Teacher interview form (G2)
This form is structured interview form prepared for obtaining the views of teachers about M-CIS. There were 12 questions in the form prepared for determining the evaluations of teachers about M-CIS use, changes he/she makes in classes, changes in instruction strategies and changes in student attitudes. The related literature (Owens *et al.*, 2007, Vollmeyer and Rheinberg, 2006, Kennewell, Tanner, Jones and Beauchamp, 2008, Yarnall, Shechtman and Penuel, 2006, MacGeorge *et al.*, 2008b) was analyzed while preparing both forms (student and teacher interview form) (G1 and G2)

Data analysis
Covariance analysis (ANCOVA), which is a statistical analysis technique used for determining the changes in student academic success because of M-CIS use, was used in the study.

Mann-Whitney U test which is a statistical analysis technique used for determining the changes in student self-regulation abilities because of M-CIS use, was used in the study. Although self-regulation scores are parametric values, as they weren't normally distributed, analysis methods used in parametric tests weren't used in this study.

Interview forms were used for teacher and student evaluations including qualitative data. Teacher interview form (G2) was used in order to obtain the evaluations of 3 different teachers giving Physics, Chemistry, Biology classes, about the system use. Student interview form (G1) was used in order to determine the difficulties experienced by students while using M-CIS, eases ensured by the system and the points that are beneficial for the learning process of students and friends. Content analysis was made in order to analyze the written data about teacher and student views. Nvivo 8.0 package program was used for content analysis.

The process of analyzing qualitative data started with transferring written documents obtained with teacher and student interviews, to the package program. In order to prepare models according to concepts and relations between these concepts, views and evaluations in each text file were classified under the name of free nodes. These free nodes were formed according to the similarities of answers. While answers of all of the questions in student texts formed 81 different free nodes, there were 30 free nodes in teacher texts. It was seen that the obtained free nodes were also grouped as; system use, effect on user, learning-instruction and learning atmosphere. It is thought that expert opinion is necessary in order to ensure reliability and security while preparing themes for nodes. This is why, opinions of four different academicians in educational sciences department were taken before creating models with nodes. Each academician made nodes-theme matching, independent from one another. As a result of the common evaluation, necessary arrangements were made, obtained free nodes were combined, and tree nodes were obtained. So, it was possible to explain the obtained views with a model. The obtained data was explained with 6 different models as equipment, usability, affective reactions, learning, instruction and finally learning environment. Teacher and student evaluations were analyzed together, models were visualized through related program. Reference numbers about the concepts were also given in these prepared models. Thus, it was attempted to determine the concepts in which teacher and student views gained importance. On the other hand, it was attempted to present the importance of each model in total teacher and student views, related with these reference numbers.

FINDINGS

In this section, statistical analysis made for finding answer to the questions determined in order to assess M-CIS use in improving the self-regulation abilities and student success in science instruction, is presented and the results are given in an order. Interpretations are made in line with the information obtained from tables and graphics about the analysis of results of each question.

Findings about determining the change in student academic success

When the experiment and control groups' statistical values were analyzed in order to present the change in student success based on M-CIS use, it was seen that point averages were close. Results of descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics about success test

	Pre-test			Post-test		
Groups	M	SD	N	M	SD	N
Experiment	13.75	3.183	142	16.21	4.976	125
Control	14.59	3.363	138	15.10	3.740	124
Total	14.16	3.294	280	15.65	4.431	249

When test points of experiment and control groups in Table 1 were analyzed, it was seen that they were not equal. While making data analysis, tests that have missing data weren't used in assessment. It was seen that there was difference between pretest and last test means of experiment and control groups. In order to see if this difference was statistically meaningful, ANCOVA test was necessary. Intergroup interaction test results about ANCOVA test are presented in Table 2.

Table 2. Success test intergroup interaction test

Dependent variable: Post-test						
Source	Sum of Squares	Df	Mean Square	F	p	η2
Model	917.77	2	458.88	28.57	.000	.189
Pre-test	840.90	1	840.90	52.36	.000	.176
Group	110.32	1	110.32	6.870	.009	.027
Error	3950.52	246	16.059			
Total	65890.00	249				

When Table 2 was analyzed, it was seen that academic success test pretest points and group variables together explain 18.9 % of the change in academic success last test points, and the ANCOVA model that defines this is meaningful ($F_{(2;\ 249)}$ = 28.575; $p \leq 0.05$). When eta-square values were analyzed, it was seen that academic success test explains 27% of the changes in posttest points in academic success, independent from pretest points. At the same time, academic success test pretest points are a significant predictor of last test points. Pretest explains ($F_{(1;249)}$ = 52.363; $p \leq 0.05$); and explains 17.6% of changes in last test scores. When differences between groups' academic success according to M-CIS use was analyzed, it was seen that; F = 6.870; $p \leq 0.05$. This result shows that there is a meaningful difference between groups. Marginal means in Table 3 should be analyzed in order to determine the group which the difference is in favor of.

Table 3. Estimated marginal means*

Dependent Variable: Post-test				
Group	M	SD	95% Confidence Interval	
			Lower Bound	Upper Bound
Experiment	16.319	.359	15.612	17.025
Control	14.985	.360	14.276	15.695

*Pretest mean calculated as cofactor: 13.75

At the end of ANCOVA, in order to determine the group that the difference is in favor of, estimated marginal means was taken into consideration instead of the means in descriptive statistics results. When Table 3 was analyzed, it was seen that group mean value for the experiment group is $X_{(experiment)}$= 16.319 while the group mean value for the control group is $X_{(control)}$= 14.985. This result shows that M-CIS make significant difference in student academic success.

Findings about determining changes in student self-regulation abilities

Motivated Strategies for Learning Questionnaire (MSLQ) was used in order to analyze the change in self-regulation abilities of students. At the end of unidimensional general evaluations and analyses, it was determined that there was no difference between experiment and control groups. As the scale is basically made of 4 sub factors, MANCOVA was thought to be used in order to determine the changes in these two factors in experiment and control groups. But it was seen in normal distribution tests that, data didn't normally distribute. This is why, Mann-Whitney U test, which is one of the non-parametric tests, was used for analysis. Descriptive statistics results about sub factors are presented in Table 4.

Table 4. Descriptive statistics for motivated strategies for learning questionnaire (MSLQ) sub factors

Sub factors	N	Mean Rank	SD	Min.	Max.
Cognitive strategies	247	50.27	7.432	23	63
Self-regulation	247	47.50	7.721	25	63
Self-efficacy	247	39.61	7.175	20	56
Internal values	247	47.21	7.462	19	63

As can be seen in Table 4, a total of 247 scale points were evaluated. According to point order, there was difference between sub factors. Results obtained at the end of order on the basis of these values are presented in Table 5.

Table 5. Motivated strategies for learning questionnaire (MSLQ) sub factors order statistic values

Sub factors	Groups	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p
Cognitive strategies	Experiment	122	119.19	14541	7038	-1.046	0.296
	Control	125	128.69	16086			
Self-regulation	Experiment	122	126.92	15484	7268	-.636	0.525
	Control	125	121.15	15143			
Self-efficacy	Experiment	122	125.86	15354	7398	-.404	0.686
	Control	125	122.19	15273			
Internal values	Experiment	122	126.52	15436	7317	-.549	0.583
	Control	125	121.54	15192			

*$p \leq 0.05$

When Table 5 was analyzed, it was seen that there was difference between experiment and control groups' order mean values in sub factors dimension according to order means. In three sub factors, order means of experiment group were higher than the control group. In order to see if this difference was meaningful, order values were taken into consideration and Mann-Whitney U test was made; the results showed that there was not meaningful difference between the experiment and control groups in terms of the sub factors of Cognitive strategies, Self-Regulation, Self-efficacy, Internal values (See. Table 5).

Qualitative analysis results about M-CIS use

In this section, analysis results of statements obtained at the end of students and teacher interviews about M-CIS use in science instruction are presented. Models that explain data were created with the help of concepts and relations obtained from these analyses. When the data obtained from teachers and students were analyzed, it was seen that the same theme was in both students' and teachers' statements. This is why, teacher and student view analyses are made by using the same themes. Themes were branched at the level of relations and modeled in the shape of tree. In order to determine the weight of models in students and teachers' views, reference numbers of concepts that form the theme are given.

Affective reactions

It was seen that system use caused differences in affective field dimension of teachers and students. According to this, concepts about the statements of attitudes and reactions acquired by individuals and values after using the system were associated with affective reactions theme. Model about affective reactions is presented in Figure 3.

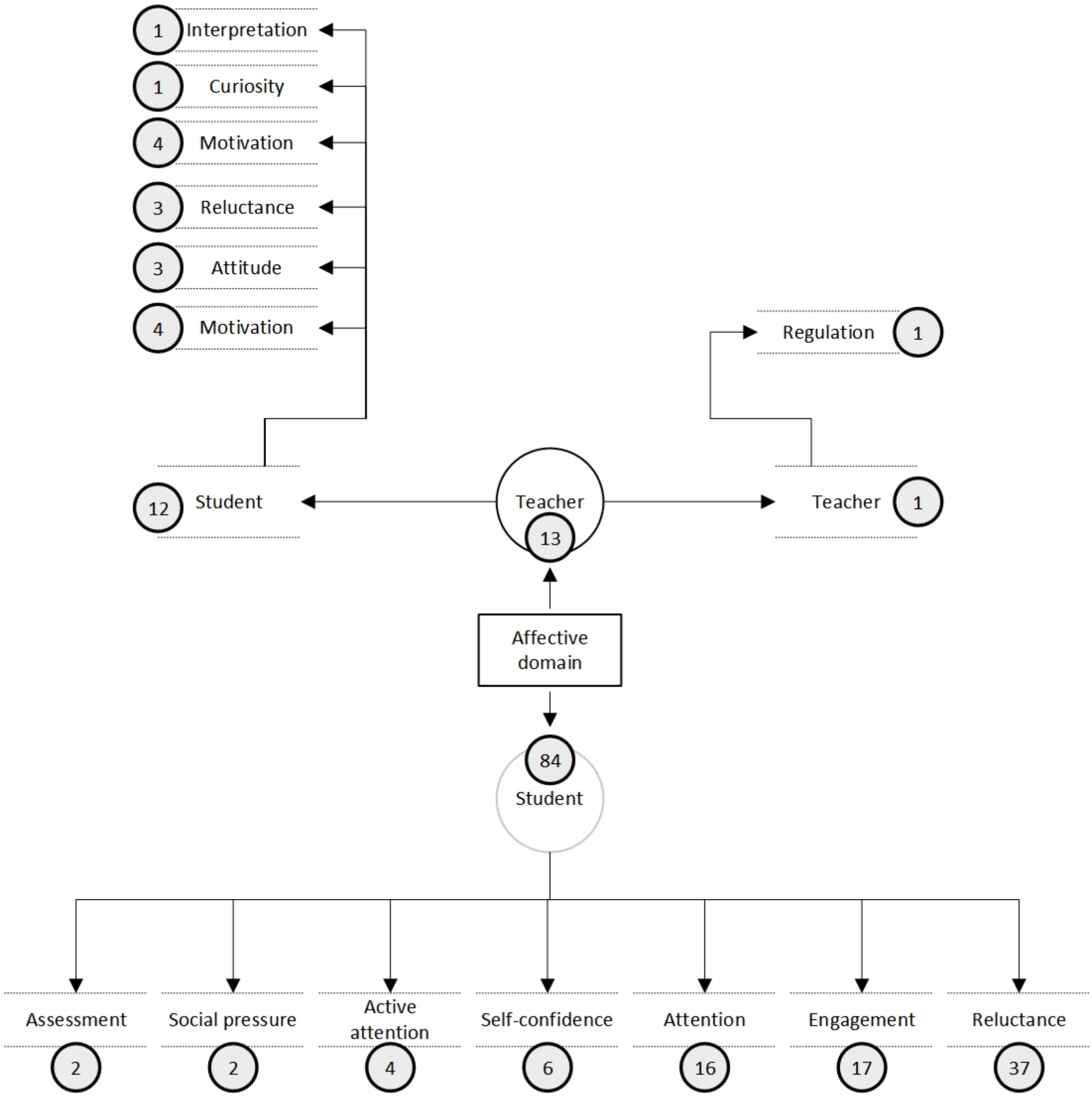

Figure 3. Affective reactions (domain)

Figure 3 includes student and teacher affective reactions towards M-CIS use. When Figure 3 was analyzed, it was seen that M-CIS use was evaluated according to a total of 97 references including 13 teachers and 84 students. 12 out of 13 references stated by the teachers, were the reactions of students while one was the affective reaction towards himself. According to these observations, teachers stated that they saw improvements in interpretation skills of students, students listened classes with a bigger attention, and the program was effective in reluctant students' attendance to lessons and increased positive attitudes. Teachers said that the biggest change occurred in terms of motivation. Students, on the other hand, stated that their attention in lessons increased, they could be more active, and the system made positive contributions to overcome their reluctance in social environment.

Learning
Views stated in learning dimension are the concepts including statements about learning new information, ensuring permanent knowledge and ensuring success in learning. Model about the learning theme is presented in Figure 4.

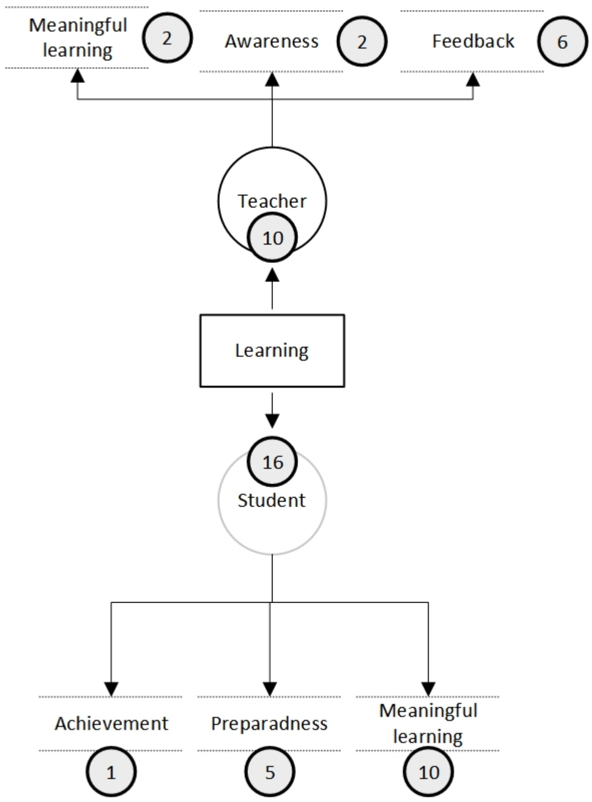

Figure 4. Learning

When Figure 4 was analyzed, it was seen that there were a total of 26 references determining the views about learning; 10 teachers and 16 students were these references. Teachers stated that as the system use helped having meaningful learning and permanent knowledge and as students had information about their learning situation, there was a high level of awareness in learning. On the other hand, they said that the system ensured obtaining feedback which is a very important need in learning.

Learning environment

Concepts such as attendance, interaction and feedback, which describe the differences in learning environment observed by teachers and students, were discussed under the heading of learning environment. The model about learning environment theme is presented in Figure 5.

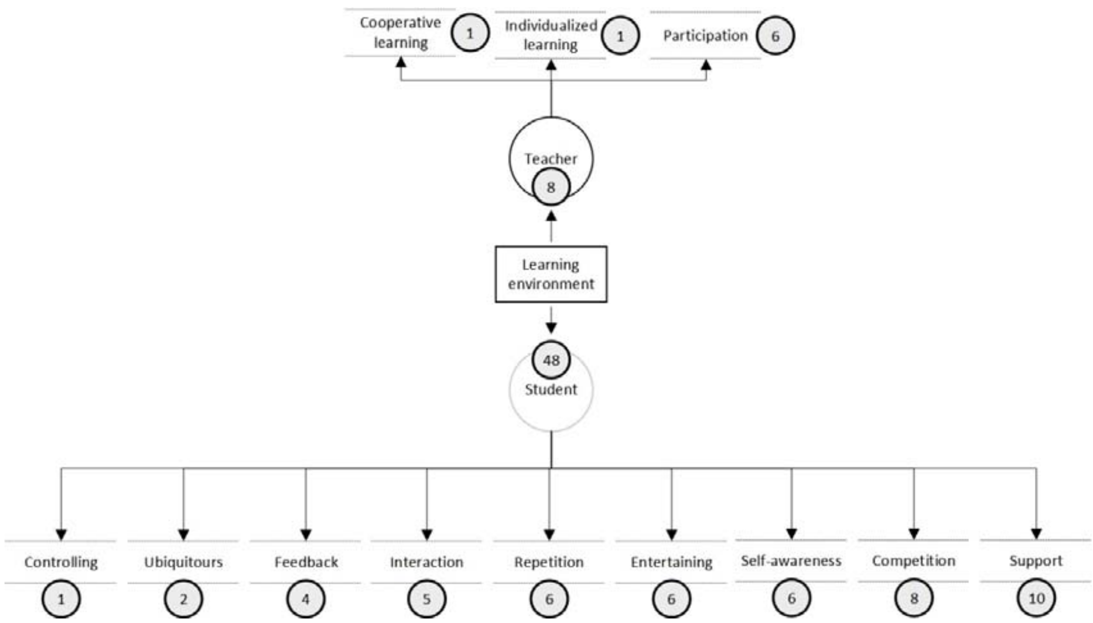

Figure 5. Learning environment

When *Figure* 5 was analyzed, it was seen that there was a total of 56 references determining the views about learning environment; 8 teachers and 48 students were these references. Teachers stated that system use gave the opportunity to cooperative learning and individualized learning in the learning environment. Students stated that with the use of the system, control was ensured better in the learning environment, there was no difference between sitting in the front row and sitting in the back, so they had the chance to participate the lessons actively. Students also said that the lesson was entertaining, because of having feedback, they had the chance to discuss in classes and they had the opportunity to share their ideas, namely interact.

Instruction
Concepts such as instruction strategies, asking question strategies, assessment and evaluation, which describe the differences in instruction observed by teachers and students, are discussed under the heading of instruction theme. The model about instruction theme is presented in Figure 6.

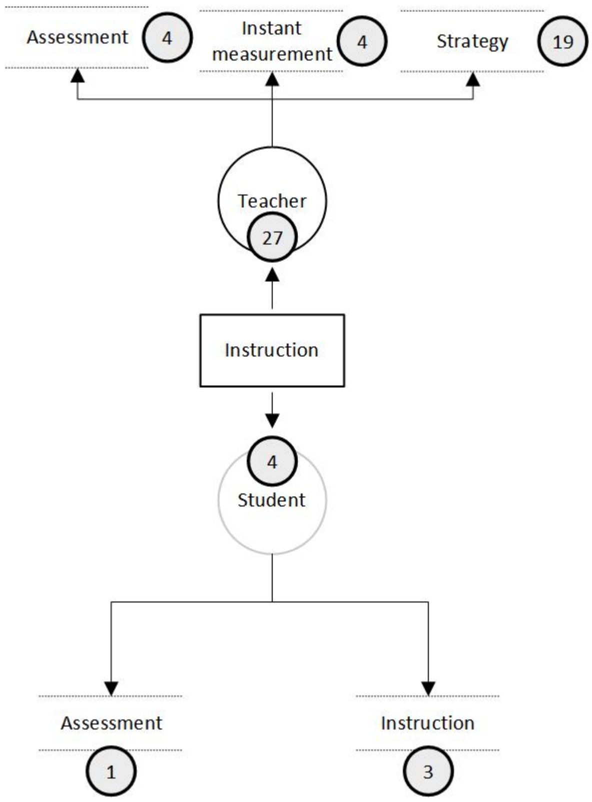

Figure 6. Instruction

When *Figure* 6 was analyzed, it was seen that there was a total of 31 references determining the views about instruction; 27 teachers and 4 students are these references. When the concept of strategy, which has the most references, was analyzed, it was seen that; teachers stated that, with the system use they were aware of their instruction, they could instantly assess instruction process and thus they could make changes in instruction strategies or asking question strategies when needed.

DISCUSSION
Results and suggestions about determining the change in student academic success
In this research, in which mobile technology use in developing student success and self-regulation abilities in science education was investigated, when the findings of the sub-research questions about determining the change in student academic success were controlled according to pretest points, it was seen that there was a meaningful difference between the points of experiment and control groups. Experiment group students who used M-CIS were meaningfully more successful than the students who didn't use the system. This result shows that M-CIS use increases student success.

Results obtained from the qualitative data of the research support this hypothesis. Student and teacher views about academic success are presented in the model explained with learning theme (Figure 4). Concepts of permanency, feedback, awareness, preparation, success in the model show that the system used in increasing academic success is efficient. Students said that system use contributed to their success. They stated that they prepared for the class and their learning was more permanent. Teachers had the same view about permanent learning ensured by the system use (Figure 4).

These results are in parallel with some of the studies in the literature. There is no study about M-CIS in the literature. But there are studies about student response system (SRS) whose technology is similar and is used as in-class communication technologies. King and Joshi (2007), determined that there is an increase in the performance of students who regularly use SRS system, and they got higher marks in exams. In their research, Nicol and Boyle (2003) used SRS in order to support discussion environment in science classes, ensuring feedback about concept tests and for supporting peer group discussion environments. At the end of the interviews with students, they determined that all of the students learnt science concepts better with instruction that is supported with the system. Caldwell (2007) stated that the use of SRS is effective in student anxiety level; success point obtained with the use of SRS is higher than the success points obtained in learning without SRS use. It is seen that in-class instruction technologies have positive effects on increasing student academic success (Mareno, Bremner and Emerson, 2010, DeBourgh, 2008, Crossgrove and Curran, 2008).

At the end of the success test, it was determined that M-CIS use contributes to increasing student academic success in science education. When this result is taken into consideration together with student and teacher views, it can be said that the system can also be used in science education for improving student success and self-regulation abilities. The designed system can be used in increasing academic success in science education. Besides this, this study, which is carried out in university science education should also be carried out in secondary school and high school levels. In this way, the designed system's effects on different education levels can be surveyed and evaluated.

Results and suggestions about determining the change in student self-regulation abilities

In this research, in which mobile technology use in developing student success and self-regulation abilities in science education is investigated, when the findings of the sub-research questions about determining the change in student self-regulation abilities were analyzed, it was seen that there was not a meaningful difference between the points of experiment and control groups. According to this result, it is not possible to say that M-CIS use has an effect on student self-regulation abilities. When the obtained findings are analyzed, it can be said that there are two basic reasons of this result. Firstly, data do not normally distribute. A better, more precise result can be obtained when an analysis is done with a data set obtained from a sample that represents the population better. Secondly, although it is commonly used, MSLQ may not be sensitive enough to measure the small changes in self-regulation abilities. So, although M-CIS use caused change in self-regulation abilities of students, this result couldn't be observed in the frame of sample and scales included and used in this research. Especially when affective reactions model (Figure 6) was analyzed, it was seen that students are more interested in classes and actively attends lessons. As students had the opportunity to see and control their correct and incorrect answers, and had the chance to correct feedback and they could make self-evaluation. It was seen that, as they were not under a social pressure while improving their learning, their self-confidence increased. As observers, teachers also stated that students were more motivated and interested in lessons and they had positive attitude towards system use.

Feedback is significant in order to make self-regulation. Feedbacks obtained during learning activities ensure students be aware of their correct and incorrect knowledge. As these feedbacks give opportunity to observe and evaluate oneself, it ensures internal feedback. These feedbacks are effective in making self-regulation during learning (Butler and Winne, 1995). Obtaining feedbacks during learning activities through system use can be effective in improving self-regulation abilities.

Student motivation and self-regulation are closely related and effective elements in academic success (Cleary, Gubi and Prescott, 2010). High motivation of student ensures carrying out responsibilities, give opportunity to make new attempts and use new strategies in terms of self-fulfillment (Zimmerman, 2002). Chosen proper new strategies and high motivation help students understand the information he/she gets better (Vollmeyer and Rheinberg, 2006). When student and teacher views were evaluated, it was seen that the system increased student motivation. The detailed research about this issue is presented in the next section under the heading of "*Evaluation results of student and teacher views about M-CIS use in science education*".

Results obtained from MSLQ, used in order to determine the change in student self-regulation abilities according to M-CIS use is not enough to evaluate the effect of the system. This is why; new experimental studies will be beneficial for determining the effect level of the system. While it is difficult to have a precise result about the effect of system through experimental studies, when qualitative data according to student and teacher views are analyzed, it is possible to say that the system is effective in student self-regulation. It is predicted that, taking these views into consideration in new studies about the use of the system in science education, will be beneficial for having a pedagogical content that is proper for system use and will make positive contributions to solving problems in instruction.

Evaluation results and suggestions about student and teacher views on the issue of M-CIS use in science education

When the views of students and teachers about the use of the system were evaluated, it was seen that M-CIS is a system that can be a solution to various problems in science education.

Students responded positively to have opportunity to make self-evaluation about correctness and incorrectness about information they obtain. Zimmerman (2002) says that self-evaluation is one of the most important factors in self-regulation. Each student has a different basic knowledge level and different learning model and this is the basic factor that determines difference in learning abilities (Zimmerman, 2002). Self-evaluation during learning is significant in this sense. The opportunity of self-evaluation through M-CIS use can be seen as a significant easiness in this sense. Self-evaluation of all of the students in a class can especially be important in improving self-regulation abilities. New studies on the level of this effect can be done.

Students said that with the use of M-CIS they could be active in class. They said that the biggest effect that enabled them be active in class is that they could state their personal opinions about questions and they were aware of the thoughts of other students. This result shows that when students have the opportunity, they become active in class. The use of Student Response System, which has a similar technologic substructure, was also made in order to ensure active engagement of students. Caldwell (2007) stated that student response system is used in order to ensure in-class coordination and student engagement in big classes. In small classes, it is easier to manage students and ensure active engagement. But as there are mostly big and crowded classes, it is significant to ensure the engagement of all of the students. It is seen that M-CIS use can be a solution to remove this problem.

Students stated that they think that group and personal success increased with the use of the system. This view is in line with the result of experimental study. When the results of ANCOVA (Table 3), which is made in order to determine the change in student success according to M-CIS use, were analyzed, it was seen that system had positive effect on academic success. These results show that M-CIS is efficient in increasing student academic success. New studies on this issue should be carried out. On the other hand, the effect of the system on other lessons should also be researched.

When the reference numbers about student and teacher views were taken into consideration, it was seen that the highest number of references is in the concept of self. Characteristically, shy student stated that they abstain from saying something in normal classroom environments and they become more passive as they are concerned about the reactions of their social environment. According to them, the use of this system helped them overcome this difficulty. Similarly, students who are normally shy stated that they couldn't always actively participate in lessons, but with this system, they could state their ideas much more comfortably. The most significant feature of the program about removing reluctance is that it enables every student state his/her view easily and his/her identity isn't known in this process. The student who states his/her opinion is not recognized by the other; he/she can answer questions and write his opinions. Some of the students stated that system use decreased their reluctance besides enabling them state opinions in other lessons, which increased self-confidence. In a good learning environment, learner should be active. The problem of reluctance is also accepted to be significant by students. It is thought that using M-CIS can be a way to overcome this problem.

Teachers think that there was an increase in student motivation with the system use. They said that, especially when they observed how students answered questions by discussions in their group, they saw that their motivations significantly increased. Motivation is a significant factor that affects self-regulation, it is basically related to success possibility, anxiety, interest and urge. While student's success possibility, interest and urge level increases during high motivation, anxiety level decreases. Motivation, which is also effective on learning output, is also effective in reaching a goal in terms of self-regulation ability (Vollmeyer and Rheinberg, 2006). When the change in student academic success according to M-CIS use was analyzed, it was seen that academic success of students who used the system was higher than the academic success of the ones who didn't use. It is thought that this contribution of M-CIS is not directly resulted from the system itself, it is resulted from motivational strategies which are effective in terms of learning output and self-regulation. This is why, student and teacher views should be taken into consideration and the effect of M-CIS on student motivational strategies should be researched in new studies.

Teachers stated that the feedbacks they get were very beneficial for them. Teachers, who said that they evaluated students learning according to learning output, stated that they could understand whether or not students understood the topic through their answers, and they could realize when there were misconceptions because of the question itself. When questions of teachers are misunderstood by students, answers can be wrong accordingly. In such cases, it is difficult to know the resource of the problem without using M-CIS. As the system presents all of the student answers to teacher, he/she can distinguish the exact resource of the problem and ensure necessary feedback. It is thought that detailed evaluation of the use of the system in terms of instruction dimension will be beneficial.

A teacher stated that the system was effective in increasing dialogue among students, so, group learning increased. Mazur (1997), who made various researches on the issue of peer instruction, stated that discussions among students are effective in learning science concepts. In his researches, he found that student answers given after making a discussion in group are mostly more correct than the answers of other students. It is seen that M-CIS is effective in establishing discussion environment among students. It is thought that using M-CIS with peer instruction or different instruction methods will be more effective in determining the place of the system in instruction.

Teachers stated that the system gave them the opportunity to have information about their instruction. Feedbacks obtained during instruction activities are important in order to evaluate instruction. Teachers who use M-CIS have the chance to determine if students understood what is told; so they stated that they could evaluate their instruction. Obtained feedbacks are important in order to make necessary changes in instruction strategies or question asking strategies. In a instruction environment in which the proper strategy is used, it is difficult for students to make sense of what is told. Similarly, teachers ask similar type of questions in order to evaluate what is learnt or students may not answer the questions as they couldn't understand what is being asked. It is thought that the designed and used system can be beneficial in solving these problems.

As a result, it was seen that M-CIS use is not only effective in increasing academic success in science education; it also has the potential to solve many problems in learning and instruction environment. Besides that, new studies should be done by preparing new application designs that are proper for different laboratory or theoretical classes. Wider sample groups should be used in new applications and new studies should be carried out on the issue of instruction science at secondary education level. Similar studies should be done for lessons besides science lessons.

It is thought that multidimensional interaction opportunity ensured by M-CIS in education can form a basis for new approaches that has been increasingly becoming significant in science education. One of these approaches is constructivist approach. The goal of this approach is to form instructional activities in a way that learners understand and learn concepts deeply and meaningfully. In order to ensure meaningful learning, it is necessary to know the concepts and misconceptions of students. In this way, teachers can organize instruction strategies according to possible misconceptions. A teacher who wants to do that should know the learning or misconceptions of all of the students about the topic. But in a laboratory environment full of students actively making experiments, this is quite difficult. As this evaluation is not sufficiently done on time in classes, it is impossible to reorganize instruction strategies according to the necessity. When a teacher asks a question through M-CIS about a topic told in the class, he can see that students are in fact insufficient in that topic and make necessary changes in instruction strategies. Teacher can have the opportunity to determine misconceptions during lessons and have information about how much is a topic understood at the end of the class.

M-CIS also supports a learning environment organized according to project and research based approaches. With this approach, which improves thinking and interpretation abilities in the frame of cause and effect instead of memorization, it is attempted to have an efficient and permanent learning besides learning through experience. Similar with the constructivist approach, social environment is significant while constructing learning. In a project, every student takes part in resulting and group study is significant. An important result obtained in this study is that students want to use M-CIS as a communication channel. They stated that developing a system that enables them establish connection with teachers or friends not only in classes, but also outside learning environment will be beneficial. It is thought that this will support students in terms of making group studies. It is believed that using M-CIS as a communication interaction platform will be effective in project and research based learning approach. This is why; the level of this effect should be researched.

Concept instruction gains more importance every day in science instruction. Although there are some techniques for determining misconceptions during an instruction process or for determining misconceptions that already exists before an instruction process, it is impossible for teachers to understand misconceptions of all of the students during a lesson about the topic he teaches. When a teacher asks a few questions at any time and evaluate the answers, it can enable him determine some misconceptions. M-CIS which ensures this in the best way, can present information about misconceptions of students in a short time. On the other hand, it is predicted that while presenting these information to teachers, the system can enable identifying misconceptions including all of the students in a class without losing a lot of time.

It was determined that M-CIS, which is designed to create classroom environments that are proper for developing student academic success and self-regulation abilities in science education, was highly successful in creating the targeted classroom environment. This is why; new studies on the issue are significant in terms of making contribution to science education and evaluating the use of the system in other disciplines.

Note: *This study is taken from the doctorate thesis*
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