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Procedia - Social and Behavioral Sciences 46 (2012) 2140 – 2147

Procedia
Social and Behavioral Sciences

WCES 2012

Conformity between the instruction programs: science-technology and mathematics

Feride Ozyildirim [a], Sevilay Atmaca [b] *, Ozge Aydin [c], Fitnat Kaptan [d]

[a] *Res. Assis. Feride Ozyildirim, Hacettepe University, Ilkogretim Matematik Egitimi ABD, Ankara, 06532, TURKEY (OYP/Aksaray University)*
*[b] *Res. Assis. Sevilay Atmaca, Hacettepe University, Ilkogretim Fen Bilgisi Egitimi ABD, Ankara, 06532, TURKEY*
[c] *Res. Assis. Ozge Aydin, Hacettepe University, Ilkogretim Fen Bilgisi Egitimi ABD, Ankara, 06532, TURKEY*
[d] *Prof. Dr. Fitnat Kaptan, Hacettepe University, Ilkogretim Fen Bilgisi Egitimi ABD, Ankara, 06532, TURKEY*

Abstract

In recent decades, in order to achieve learning based on understanding, the importance of interdisciplinary teaching and multi-dimensional approach towards the problem solving has been emphasized, along with the integration of disciplines. The most suitable programs for such multi interdisciplinary approaches are Science-Technology Instruction Programs (STIP) (Ministry of National Education [MNE], 2006) and Mathematics Instruction Program (MIP) (MNE, 2008) due to the magnitude of available application areas and similarities in the approaches used towards problem solving in these disciplines (National Research Council [NRC], 1996). Thus our research is based on the exploration to the question: 'How does STIP relate middle school content to MIP in order to establish interdisciplinary connections'. Descriptive situation analysis is used and all data is obtained through 'document analysis method' and 'interviews'. The STIP is the central focus in our analysis. In the STIP, all learning material is categorized under four themes (MNE, 2006): Livings and Life, Physical Acts, Substance and Change, Earth and Cosmos all of which are analyzed in this research. In this study, the details of 'Rudiments Related to Unit Organization-Explanations' in STIP and the dimension of 'Association with Other Disciplines' in MIP are taken into consideration (MNE, 2006; MNE, 2008). This research shows that while connections from SCIP to MIP were done directly and effectively for the 6th grade level, such a direct connection was not exist for the 7th and the 8th grade levels. However the analyses of programs indicate that the 6th grade level instruction program is supported with in-direct connection by the example activities, only in-direct connections are exist in both 7th and 8th grade levels' instruction programs. Based on the findings of this study, suggestions are made both to the authors of the textbooks and the developers of the curriculum, to make these connections more explicitly and more effectively. Moreover, some suggestions can be also made to teachers who are the applicators of the programs according to our findings.

Keywords: Science and Technolgy Instruction Program, Mathematic Instruction Program, Interdisciplinary Connections, Integration.

1. Introduction

According to Ertürk (1979), education is the changing process of individual's behavior to the desired and expected direction. The main purpose of education is making students learn how to reach the information, instead of prepared and ready one directly. This situation can be real only if mental process skills occur. It means that, in order to be a problem solver, learning by understanding and avoid from memorization, Science-Technology Instruction

* Corresponding Author name. Res. Assis. Sevilay Atmaca, Hacettepe University, Ilkogretim Fen Bilgisi Egitimi ABD, Ankara, 06532,TURKEY
Tel.: +903122978626
E-mail address: atmaca@hacettepe.edu.tr

1877-0428 doi:10.1016/j.sbspro.2012.05.443

Program (STIP) in one of the important point that cause students to gain those abilities (Kaptan, 1999). Erden (1998) noted that, the quality of education depended on the quality of instruction programs had applied. From this point, the instruction programs are modified according to the needs of society, students and expectations. That's why, the connection of the different disciplines is stressed in the instruction programs, like done in the modified STIP in 2005.

Both of STIP, and MIP are so important in terms of the mental development of students. According to Çoban (2002), the requirement of mathematics education is as important as the requirement of language education. Since the education of mathematics is so important, the mathematics curriculum must be suitable for the needs of life. By the help of a suitable curriculum, students will become good problem solvers, successful at group work and as a result they have self-efficacy towards mathematics (Baki, 2006). For this reason a reform was done in 2004 in the elementary mathematics education program. With the reform done, new mathematics curriculum become student centered, instead of teacher centered. Students take an active role during the learning process. They reach the necessary information by searching not from the teacher. In addition to that, pedagogies of education have been changed to constructivism from behaviorism (Bulut, 2007). In the constructivist approach, students form their own mathematics knowledge by discovering, and living. Moreover, new curriculum also supports the usage of technology like using calculators for fundamental operations during problem solving or computers for increasing the visuality of students.

Moreover, when related literature analyzed, it is seen that the term integration of different disciplines is not new and it is based on constructivist theory (Vars, 1991; Petrie, 1992; Childress, 1996; Czerniak, Weber, Sandmann and Ahern, 1999; Loepp, 1999). It is convicted on that the interdisciplinary integration can help students learn to think critically and help to gain deep understanding, gain deductive perspective, make connections among central concepts, integrate scientific processes, enhanced problem solving skills, promote communication skills and creativity by this way keep interested and motivated in school (Petrie, 1992; McDonald and Czerniak, 1994; Childress, 1996; Austin, Hirstein and Walen, 1997; Barab and Landa, 1997; Venville, Wallace, Rennie and Malone, 1998; Czerniak and et al., 1999; Loepp, 1999; Hurley, 2001). Many research show that integration and interdisciplinary connections can construct among many learning themes, course and concepts such as science, mathematics, physical education, health education, foreign languages, social studies, language arts, fine arts, vocational education and etc. (McDonald and Czerniak, 1994; Loepp, 1999). According to Petrie (1992), interdisciplinary integration can hold in science and mathematics education primarily because of the suggestions they make regarding the relations of these disciplines to problem solving and everyday experience. After the reforms in mathematics and science education (American Association for the Advancement of Science, 1989; National Council of Teachers of Mathematics, 1989), "with the new proposed standards, may now be entering one of the problem-oriented phases, and in this respect will begin to appear more interdisciplinary" (Petrie, 1992). From this point, the importance and requirement of integration between science-technology instruction program and mathematics instruction program can be seen obviously.

As a result, it is obvious that the integration of STIP and MIP is so important, since a kind of study cannot be seen that examine the connections between those two programs such as connections between objectives and connection between activities in the center of STIP. That is why, this research is based on the find that 'How does STIP relate middle school content to MIP in order to establish interdisciplinary connections'.

2. Method

Because of the conformity between STIP and MIP this research is taken under construction. The study was done by using "descriptive situation analysis" and data were obtained by the "document analysis method" and "interviews". Creswell (2007) features five forms of data include both document analysis and interviews.

Field workers often pick up a wide range of documents from their sites: meeting, agendas, evaluation reports, newspaper articles, brouchers, minutes of meetings, rosters. The list is not endless but very large. Documents are often lengthy and typically need clarifying and summarizing. It's help to create and fill out a document summary

form, which puts the document in context, explains its significance, and gives a brief summary (Miles and Huberman, 1994). From this point a document analysis form was prepared by researchers in order to analyze qualitative data obtained from related documents.

According to Creswell (2007) "interviews play a central role in the data collection" and "focus groups are advantageous when the interaction among interviewees will likely yield the best information, when interviewees are similar and cooperative with each other". For this reason focus group interviewing was chosen by researchers in order to gather teachers' opinion on STIP and MIP.

2.1. Data Analysis

In descriptive situation analysis method the data is commented and summarized according to the determined themes before, by using written materials and analyzing the facts which are targets of research (Yıldırım and Şimşek, 2005).

In this research, fallowing steps are done one by one for the descriptive situation analysis and notes were written on document analysis form and interview forms. Firstly, for document analysis, updated forms of STIP and MIP are obtained from the web site of Ministry of National Education (MNE). Secondly, the objectives and activities of two instruction programs are examined. Thirdly, objectives and activities in STIP and MIP which address to each other are checked if they are two sided or not. From this point, all 6th, 7th and 8th grade STIP learning areas which are "Livings and Life", "Physical Acts", "Substance and Change" and "Earth and Cosmos" are examined in the center of STIP with the connection of MIP. Lastly, findings obtained from two instruction programs are given in tables and commented. Then for the interviews, eight questions related to the STIP and MIP were asked to the three mathematics teachers and five science and technology teachers as a focus group. The teachers have teaching experiences between 8 years to 15 years. Those questions were developed by the help of related literature and the experiences of the researchers. The focus group interview was taken 41 minutes. The findings are given in the next part of this study. For the analysis of the interviews three researchers coded the themes for the triangulation. Flick (2011) describes this type of triangulation as "investigator triangulation". Investigator triangulation can be use when necessary to include more than one researcher. Creswell (2007) mentions investigator triangulation in qualitative research validation strategies to provide corroborating evidence.

3. Findings

3.1. Findings of Document Analysis

In this study, the details of 'Rudiments Related to Unit Organization-Explanations' in STIP and the dimension of 'Association with Other Disciplines' in MIP are taken into consideration. During our research two types of connections were determined. The first type is can be named as 'direct connections' that were shown in the instruction programs obviously. Those direct connections were given in Table 1. Apart from direct ones, there are some 'in-direct connections' which were given in the example activities in STIP. Before examining the details of both types, the direct connections from STIP to MIP are given in Table 1.

As shown from Table 1, direct connections were done from 6th grade STIP's units named 'Fertility, Growth and Development', 'Force and Movement' and 'Light and Sound'. However, three direct connections were seen in 6th grade STIP and MIP, there are no direct connections in 7th or 8th grade instruction programs. In table 2, the explanation of those connection details are given.

According to the table given (Table 2), the direct connections between STIP and MIP were done only in the 6th grade curriculum. The first connection was done between 'Livings and Life' learning area in STIP and 'Probability and Statistics' learning area in MIP. By linking those two learning areas, the STIP objective that is 'to comment the changes in age, height, mass and their relation related to growth' can be achieved by using the related MIP objective 'to form questions and collect data for researches.' This connection is useful for both instruction program and that shows the suitable conformity. The second connection was done between 'Physical Acts' learning area in STIP and

‘‘Probability and Statistics’ learning area in MIP. Different from the first connection, in the present instance two objectives of STIP was linked to the objective of ‘to show the data with suitable statistics model and comment that model’ in MIP. The last connection was done between ‘Physical Acts’ learning area in STIP and ‘Geometry’ learning area in MIP. The objective of STIP that is ‘to explore the equality of incident angle and reflection angle by using planar mirror’ is linked to the related MIP objective ‘to construct an equal angle for given angle and separate an angle in two parts’. The three objectives from the ‘Physical Acts’ learning area in STIP that is connected to the ‘Probability and Statistics’ and ‘Geometry’ learning areas in MIP are in a right connection and related to each other.

Table 1. The direct connections from STIP to MIP

Grade	SCIP Units		Connection with MIP
6th	1.	Fertility, Growth And Development	+
	2.	Force And Movement	+
	3.	Particulate Structure Of Matter	-
	4.	Electricity In Life	-
	5.	Systems Of Human Body	-
	6.	Matter And Heat	-
	7.	Light And Sound	+
	8.	What Are The Components Of Earth Crust?	-
7th	1.	Systems Of Human Body	-
	2.	Force And Movement	-
	3.	Electricity In Life	-
	4.	Structure And Features Of Matter	-
	5.	Light	-
	6.	Human And Environment	-
	7.	Solar System And Its Beyond	-
8th	1.	Division Of Cell And Heritage	-
	2.	Force And Movement	-
	3.	Structure And Features Of Matter	-
	4.	Sound	-
	5.	States Of Matter And Heat	-
	6.	The Relation Between Livings And Energy	-
	7.	Electricity In Life	-
	8.	Natural Processes	-

As seen from those examples, there are both relevant and irrelevant situations between two instruction programs. For instance, in the 6th grade ‘Livings and Systems of Human Body’ unit in STIP, the example activity related to carbon dioxide and oxygen percentages during the inhalation process is one of the in-direct connection between the two instruction programs. According to the given percentages, the activity asks students to show the process by using bar graph. However, this connection was not mentioned in the instruction programs directly, in the example activities the connection can be seen obviously. Another example activity is in the 7th grade STIP about biologic diversity in ecosystem. In this activity, it is asked students to comment the given table, and then draw a right bar graph. The connection seen in this activity between STIP and MIP draw the attention about the relevance of learning areas. The other in-direct connection example for the 7th grade STIP is about ‘Solar System and Its Beyond’. The aim of this activity is make students calculate the distances of planets from the sun and form a table about the calculation results. The first example activity of the 8th grade that shows the in-direct connection between the STIP and MIP is in the ‘Force and Movement’ learning area. The activity process is about problem solving and comparing the quantitative data. It is aimed to make students fill the given table by obtained data. The other example activity of 8th grade STIP is about the change in the temperature of a liquid according to time. At the end of the activity a time-temperature graph is going to be drawn by using the information in given table. The last activity is oriented to form a table with the data obtained by observing the weather forecast, atmospheric pressure and heat, at the same time interval in a week in their own town. From all given activities it is obvious that besides the direct connections, also in-direct connections are present. From this point it appears that there is a strong conformity between the STIP and MIP.

Table 2. The direct connections from STIP to MIP

STIP			MIP		
Learning Area	Unit	Objective	Learning Area	Sub-Learning Area	Objective
Livings and Life	Fertility, Growth and Development	To Comment the changes in age, height ,mass and their relation related to growth	Probability and Statistics	Forming Questions and Collect Data For Researches	To form research questions, select suitable sample and collect data
Physical Acts	Force and Movement	To express the relation between total time and velocity, total distance and apply for different situations To show the relation between total distance and total time with graphs and comment the graph.	Probability and Statistics	Tables and Graphs	To show the data with suitable statistics model and comment that model.
Physical Acts	Light and Sound	To explore the equality of incident angle and reflection angle by using planar mirror	Geometry	Angles	To construct an equal angle for given angle and separate an angle in two parts.

When the activities in 8th grade STIP are analysed, there are eleven activities in four learning areas' activities have connections with MIP. Two activities, have connections with MIP, are in the 'Matter and Change' learning area in STIP. In the 'Matter and Change' learning area, 'States of Matter and Heat' unit has two activities named 'solid melted, liquid boiled' and 'let's draw and comment graphs'. These activities are related with the sub-learning area 'Graphs' in 'Probability and Statistics' learning area of 7th grade MIP. The other two activities, have connections with MIP, are in the 'Physical Acts' learning area in STIP. 'How much we paid' activity is in the 'Electricity In Life' unit is related to in 'Rate and Proportion' sub-learning area in 'Numbers' learning area of 6th and 7th grade MIP. The forth activity is 'read' in the same learning area and unit with the previous activity, but the activity only is related to 7th grade MIP. The last example activity in the 8th grade STIP is named 'one week weather forecast observation project'. This activity is in the 'Natural Processes' unit of the 'Earth and Cosmos' learning area in STIP and has a connection with 'Tables and Graphs' sub-learning area of "Probability and Statistics' learning area in 6th grade MIP.

3.2. Interview Analysis

In the analysis of the interviews, four different themes were found by three different field area researchers. Those themes were planning the teaching-learning process, forming the instruction content, clarity of the instruction program (STIP and MIP) and connections between STIP and MIP.

3.2.1 Planning the teaching-learning process

The teachers indicate that they use the STIP and MIP for determining the objectives, sample activities, teachers' guide books and course books. One of those teachers says that; "*The objectives guide me and I am using the course books sometimes. In addition to that, I am using the teacher's guide book. Instead my main purpose is giving the objectives to the students."*

Table 3. Relevant and irrelevant connections of STIP and MIP

STIP			MIP	
Learning	Unit	Objective	Learning Area	Sub-Learning

	Area			Activity Name		Area
6/1	Livings and Life	Fertility, Growth and Development	2.6	multiple choice question	Probability and Statistics	Tables and Graphs
6/2	Physical Acts	Force and Movement	1.1, 1.2, 1.3, 1.4, 1.5	calculate the velocity	algebra	equations
6/2	Physical Acts	Force and Movement	3.1, 3.2, 3.3, 3.4, 3.5, 3.6	balanced and unbalanced forcements	algebra	equations
6/5	Livings and Life	Systems Of Human Body	3.2	multiple choice question	numbers	percentage
6/7	Physical Acts	Light And Sound	1.5	carry the light with reflection	Geometry	Angles
7/6	Livings and Life	Human And Environment	1.5	commenting table and drawing graph	Probability and Statistics	Graphs
7/7	Earth and cosmos	Solar System And Its Beyond	2.1, 2.2	The distances of planets to the sun	algebra Numbers	6^{th} grade Pattern and relations 8^{th} grade Pattern and relations 8^{th} grade Exponent numbers
8/1	Livings and Life	Division Of Cell And Heritage	2.3, 2.4, 2.5, 2.6 2.8	decoding the meaning open-ended question open-ended question performance assessment	Probability and Statistics	Basic concepts of proportion
8/2	Physical Acts	Force and Movement	2.1, 2.2, 2.3	trace on soil	measurement	Surface area of geometric shapes
8/4	Physical Acts	Sound	5.1, 5.3	rule of echo	7^{th} grade algebra	Equations
8/5	Matter and Change	States Of Matter And Heat	4.1, 5.1, 6.1, 6.2	solid melted, liquid boiled	7^{th} grade Probability and Statistics	graphs
8/5	Matter and Change	States Of Matter And Heat	5.1, 6.1, 6.2	let's draw and comment graphs	7^{th} grade Probability and Statistics	graphs
8/7	Physical Acts	Electricity In Life	3.1, 3.2, 3.3, 3.4, 3.5	how much we paid?	6^{th} 7^{th} grade Numbers	Rate and proportion
8/7	Physical Acts	Electricity In Life	3.1, 3.2, 3.3, 3.4, 3.5	read	7^{th} grade Numbers	Rate and proportion
8/8	Earth and cosmos	Natural Processes	3.2, 3.8	one week weather forecast observation project	6^{th} grade Probability and Statistics	Tables and Graphs

3.2.2. Forming the instruction content

The teachers say that, they are using the objectives and sample activities again to form the content of the instruction. Moreover, they are using different sources in order to form the courses they give. For example one

teacher says; *"I am using both the internet and the popular sources related to our courses to form my instruction. However, we cannot do the given activities in the instruction program always; we are using different activities usually."*

3.2.3. Clarity of the instruction program (STIP and MIP)

The teachers express that the instruction programs are not too clear to understand. They say that their experiences and communications are beneficial to make the programs clear. One of those teachers says that; *"The instruction program can guide us but, the connections with the other disciplines are not clear and not detailed."* Another teacher says that *"We can understand if the connections are clear or not when we talk about on it with collogues. Sometimes with working together, we can do some arrangements on the course contents."* Also especially the mathematics teachers say that the MIP is so complex to understand since even the mathematics teaches cannot understand it sometimes.

3.2.4. Connections between STIP and MIP

The teachers indicate that the time is not adequate to apply the given activities since the instruction programs are too dense. They said that the instruction programs do not contain enough common objectives so that brings teachers extra work. For example one teacher say that *" I can try to explain students the connections of the objectives from MIP to STIP, but since the programs are so dense, I cannot give the detailed information to the students about that connections. For instance when I do the course related to proportion in mathematics, I want to show the examples in STIP, related to liquid solution topic and in Social Sciences, related to scaling topic. However the timing of those topics is not suitable in the instructions programs to make good connections."* Moreover, another teacher indicates that, especially in the 8th grade, the common activities and objectives are not enough.

4. Discussion and Suggestion

This research shows that while connections from STIP to MIP were done directly and effectively for the 6th grade level, such a direct connection was not exist for the 7th and the 8th grade levels. However there is not a direct connection for those grade levels, some example activities show in-direct connections between the two instruction programs. There are two important points found out about both direct and in-direct connections done. The first important point is that the direct connections were seen only in the 6th grade level's three different units of STIP. There are eight units in 6th grade level's STIP, and those direct connections are done for only three units out of eight which cannot be enough for required conformity of programs. While the number of direct connections is not enough, the instruction programs of 6th grade are supported by the in-direct connections. On the other hand, only in-direct connections are given in the 7th and 8th grade level STIP. It is seen that, those in-direct connections are all related about forming a table and drawing bar graph topics in MIP; that is the second important point of this research.

Based on those findings of this study, some suggestions are made both to the authors of the textbooks and the developers of the curriculum, in order to make those connections more explicitly and more effectively. In addition to that the number of direct connection can be increased to make the conformity of two instruction programs stronger. Besides, the connections can be made not only between the limited learning areas, such as tables and bar graphs, but also those connections should be developed by various learning areas and units for both instruction programs. Moreover, some suggestions can be also made to teachers who are the applicators of the programs according to our findings. For instance, teacher can choose examples and activities which are suitable to make connections between those two programs. In this manner, it can be thought that those kind of suitable activities support the time saving and permanent learning.

Besides that, four themes are found as a result of the interviews with the teachers. Those themes are planning the teaching-learning process, forming the instruction content, clarity of the instruction program (STIP and MIP) and connections between STIP and MIP as indicated below. The teachers use the instruction programs to plan and form the course contents and to see the objectives. The teachers says that the instruction programs are so dense, time

is not enough to apply the all given activities. In addition to that, both the programs and the connections between STIP and MIP are not clear. Their experiences and communications are more helpful than the instruction programs to form the course content. Venwille and friends (1998) found similar results from their study. They showed that for many teachers curriculum integration threatens existing structures of power and control in schools. In a similar vein Childress (1996) mentioned that the promount consideration was common planning time for the teaching team during the regular school day. For him common planning means teachers must commit to regular meetings and work together.

To sum up, since the integration of those two programs is so important in terms of permanent learning, other researches can be done about the conformity between other instruction programs such as; fine arts, social sciences, language education, physical education and etc. (McDonald and Czerniak, 1994; Loepp, 1999).

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