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Constructing a Multi-Tier Application in ASP.NET

The references provide different approaches to constructing a multi-tier application in ASP.NET.

- A "connected model " where there is an open connection to the database vs. a "disconnected model" where an in-memory representation of the data is used. According to Walter et al (p. 889), while the latter provides more functionality, it runs slower. Since I will be constructing a very simple example, I will use the former.
- Extent to which Visual Studio tools and ASP.NET objects are used – Below I use Visual Studio and write less code than other approaches might use.

The steps outlined below sketch one incomplete approach to the topic.

Steps:

- Create the database – To create a new SQL Server Express Edition database with Visual Web Developer or Visual Studio, create a new website using the Empty ASP.NET template. To add a database, go to Solution Explorer, right click on the website name, choose Add New>SQL Server Database. You can respond yes about putting the database in the App_Data folder.

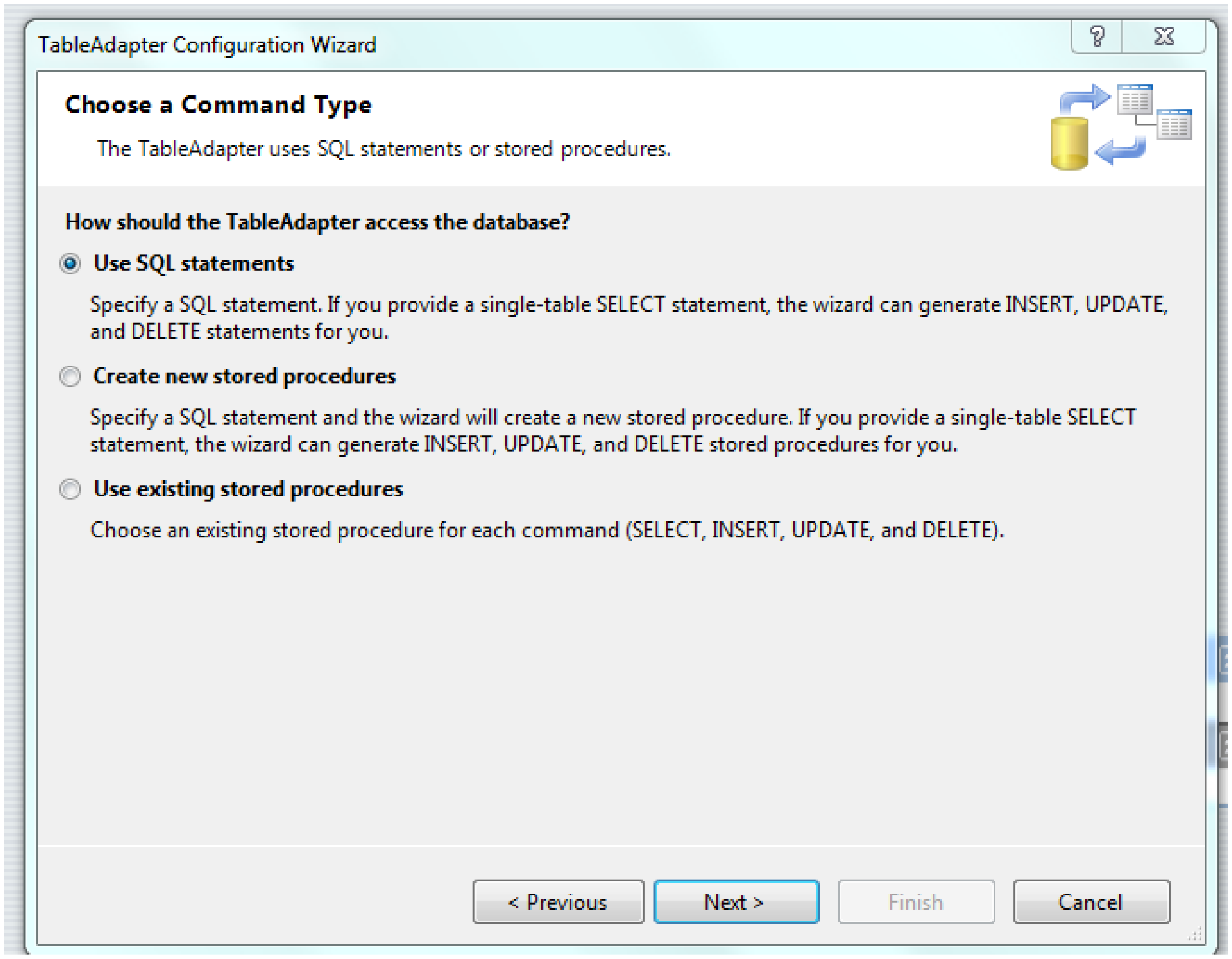
- Creating Database Tables – In VWD or Visual Studio, using Database Explorer, right click the Tables folder and choose the Add a New Table option. Enter information for the field name, datatype, and Allow Null columns.
    - To designate a field as the primary key, select the row showing the appropriate field name and then click the primary key icon in the toolbar or right click the row and choose Set Primary Key.
    - To mark a field as auto-increment, select the appropriate row column and then in the Column Properties at the bottom, find the Identify Specification property, expand it and change the (Is Identity) option to Yes.

  For this example, we will have a single table named Student and three fields –
    - Id – int – primary key, auto-increment
    - student – varchar(50)
    - score – int

      In this example, I will uncheck the "allow nulls" for all three fields.

- Adding Data to the Tables - Right click on the table in the Database Explorer and select the Show Table Data option and enter the data. Where you see red exclamation point icons, the record has yet to be created so click in the next record or Tab to it, to save the record.

- Adding a New DataSet to the Project – Right click on the project node in the Solution Explorer and choose Add a New Item. Select the DataSet option and give it a suitable name. When prompted about whether to add it to the App_Code folder, choose Yes.
- Adding a TableAdapter to the DataSet – Right click>Add>TableAdapter. The TableAdapter Configuration Wizard begins by prompting you to select the database – choose it from the dropdown menu. After clicking Next, you will be asked if you want to save the connectionStinrg in the web.config file, and choose yes. You will then see the following screen and choose the "Use SQL statements" default.



Choose a Command Type

The TableAdapter uses SQL statements or stored procedures.

How should the TableAdapter access the database?

[✓ **Use SQL statements**]

Specify a SQL statement. If you provide a single-table SELECT statement, the wizard can generate INSERT, UPDATE, and DELETE statements for you.

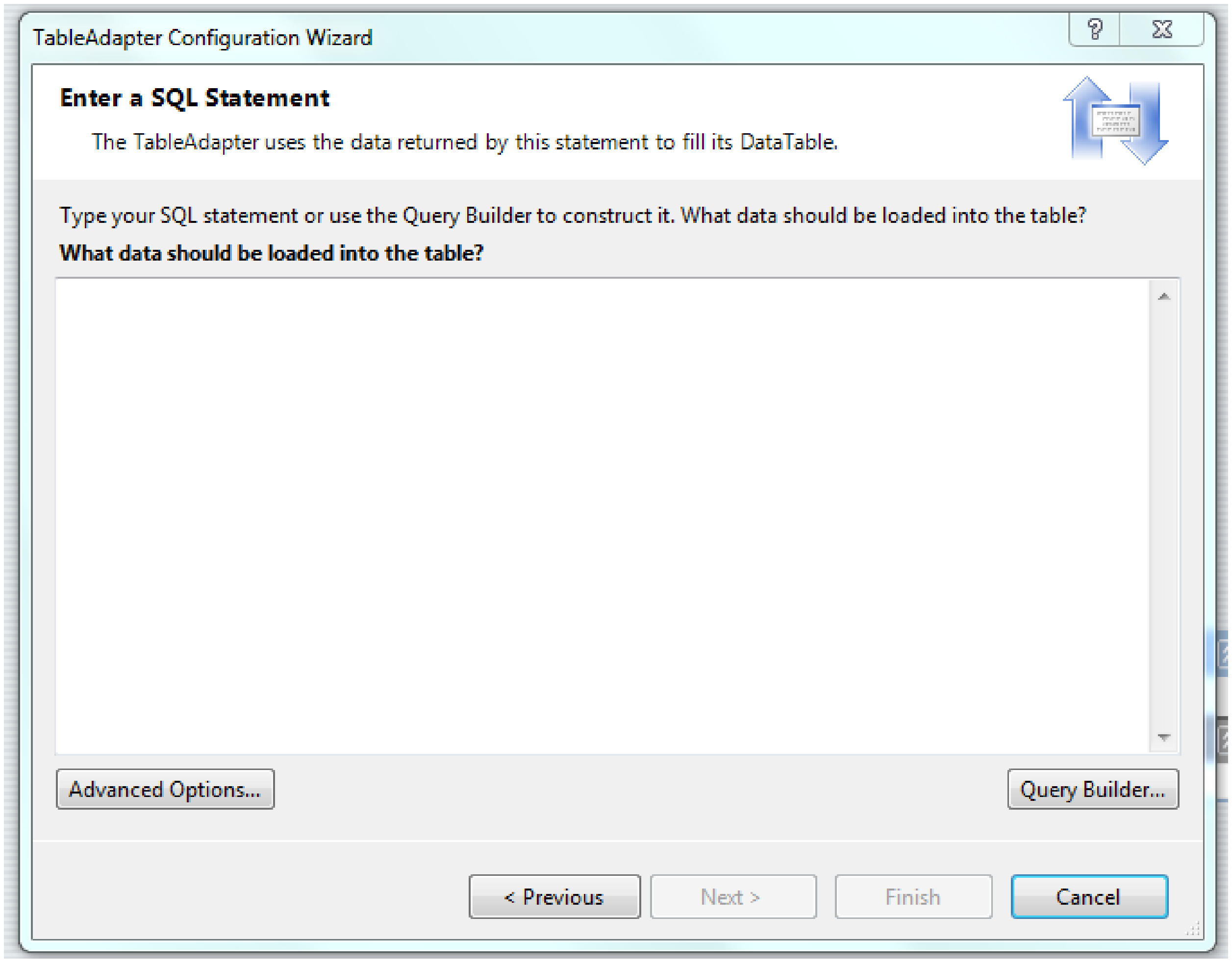
Create new stored procedures

Specify a SQL statement and the wizard will create a new stored procedure. If you provide a single-table SELECT statement, the wizard can generate INSERT, UPDATE, and DELETE stored procedures for you.

Use existing stored procedures

Choose an existing stored procedure for each command (SELECT, INSERT, UPDATE, and DELETE).

You will then see the following screen where you can either type in a SQL statement or use the Query Builder to build it.



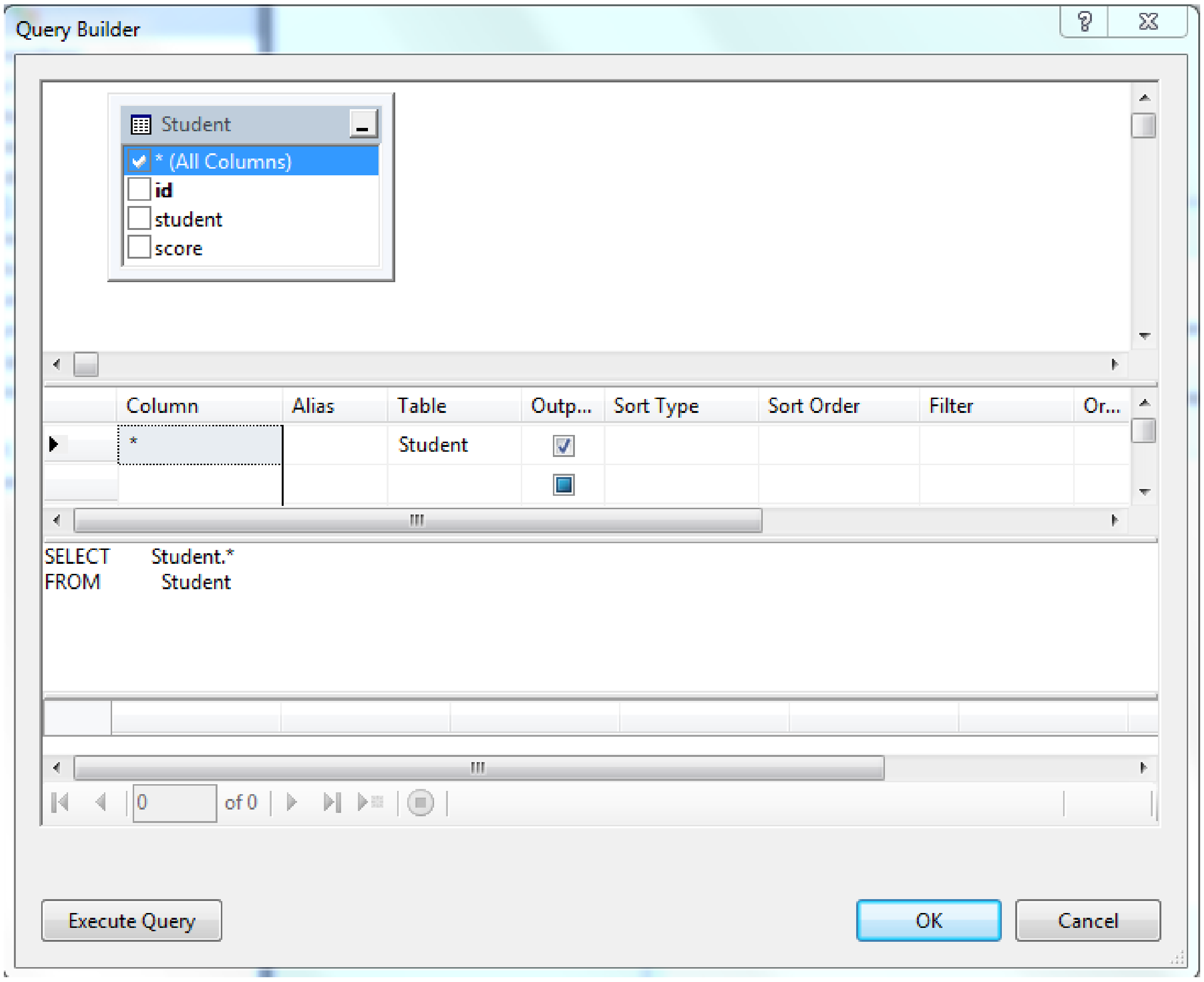
Enter a SQL Statement

The TableAdapter uses the data returned by this statement to fill its DataTable.

Type your SQL statement or use the Query Builder to construct it. What data should be loaded into the table?

What data should be loaded into the table?

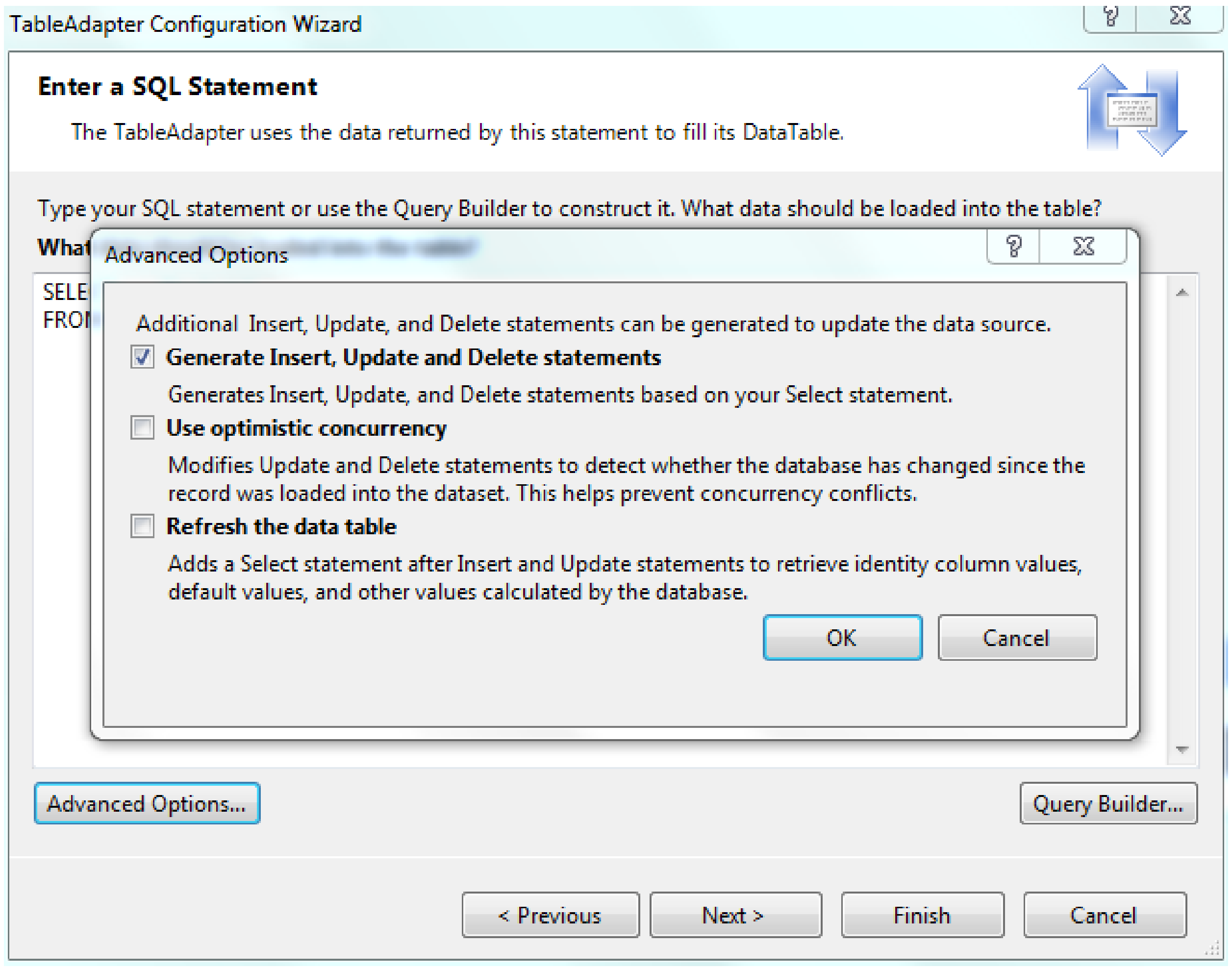
The following screen shows selecting all columns using the * in the Query Builder



	Column	Alias	Table	Outp...	Sort Type	Sort Order	Filter	Or...
▶	*		Student	✓				
				■				

```
SELECT      Student.*
FROM         Student
```

After the Query is built, click the Advanced Options button at the lower left and you will see the following screen:


TableAdapter Configuration Wizard

Enter a SQL Statement

The TableAdapter uses the data returned by this statement to fill its DataTable.

Type your SQL statement or use the Query Builder to construct it. What data should be loaded into the table?

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Advanced Options

Additional Insert, Update, and Delete statements can be generated to update the data source.

[✓] **Generate Insert, Update and Delete statements**

Generates Insert, Update, and Delete statements based on your Select statement.

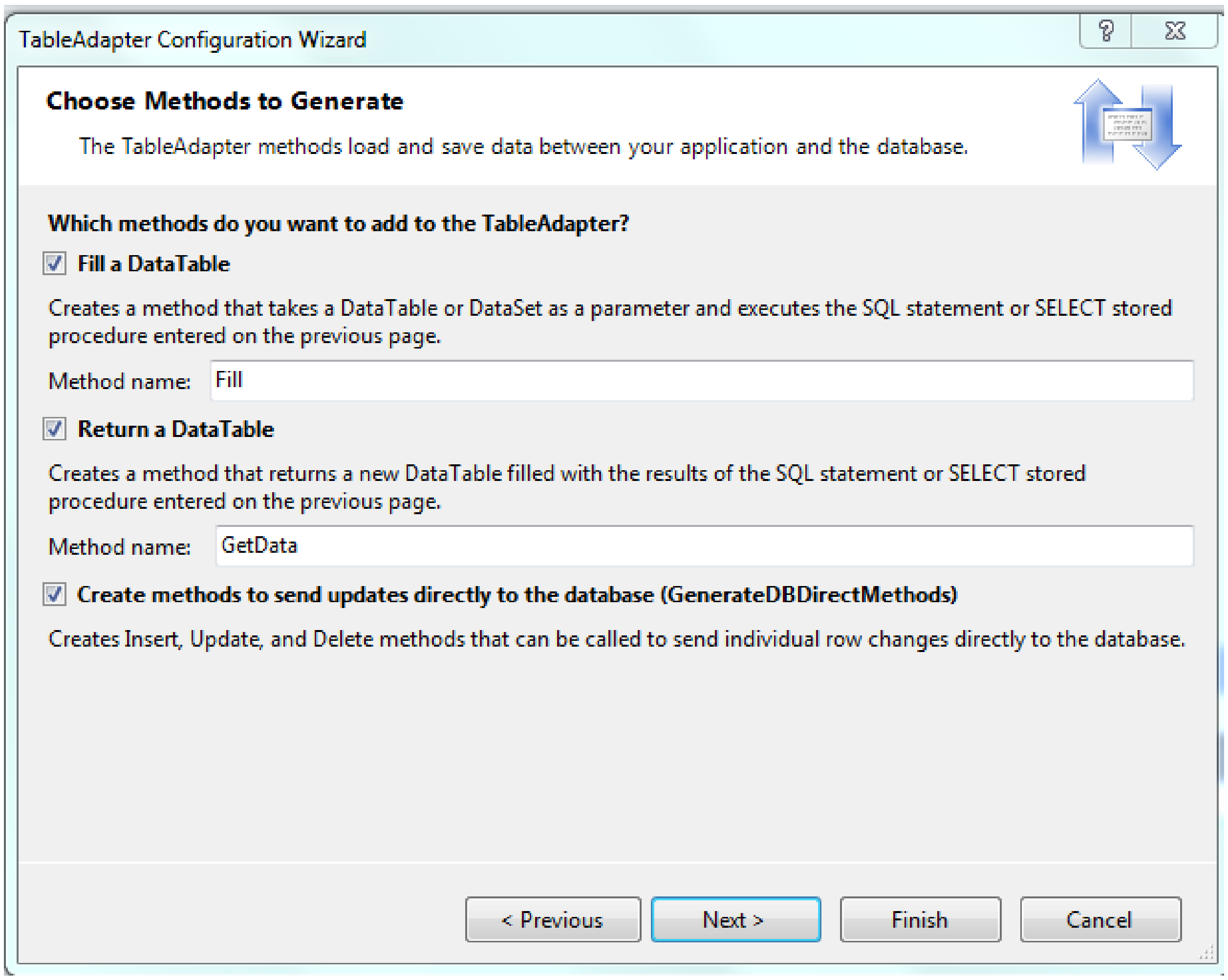
[ ] **Use optimistic concurrency**

Modifies Update and Delete statements to detect whether the database has changed since the record was loaded into the dataset. This helps prevent concurrency conflicts.

[ ] **Refresh the data table**

Adds a Select statement after Insert and Update statements to retrieve identity column values, default values, and other values calculated by the database.

And accept the defaults and clicking Next will take you to the following screen:


TableAdapter Configuration Wizard

Choose Methods to Generate

The TableAdapter methods load and save data between your application and the database.

Which methods do you want to add to the TableAdapter?

[✓] **Fill a DataTable**

Creates a method that takes a DataTable or DataSet as a parameter and executes the SQL statement or SELECT stored procedure entered on the previous page.

Method name: Fill

[✓] **Return a DataTable**

Creates a method that returns a new DataTable filled with the results of the SQL statement or SELECT stored procedure entered on the previous page.

Method name: GetData

[✓] **Create methods to send updates directly to the database (GenerateDBDirectMethods)**

Creates Insert, Update, and Delete methods that can be called to send individual row changes directly to the database.

To keep the code simple for this example, I will uncheck the first and third boxes so as to only return a DataTable – you can rename this method to make it more specific.

Creating a Business Logic Layer

Rather than implementing the Business Logic Layer and Presentation layers as separate Class Library projects, we'll implement these as classes in our project. To make things clearer, we will create separate folders – so right click on the App_Code folder and add two new folders – DLL r and BLL. Drag the TypedDataset previously created into the DataAccess folder.

Right click on the BLL folder, choose New Item, and choose Class. We will use a separate class for each table in our database – data access layer (in this case, there is only one). Ultimately we will need four methods:

- GetStudents() – return all students
- AddStudent(student, score) – inserts a new student into the database using these values

- UpdateStudent(student, score, id) – updates the specified record
- DeleteStudent(id) – deleted the specified record

but for now, we'll just do the GetStudents() method.

We'll begin with the following code:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;
using MultiTierTableAdapters; //MultiTier is the name of the database

public class StudentBLL {
    private StudentTableAdapter _studentAdapter = null; // Student is the table name
    public StudentTableAdapter Adapter // this is the property corresponding to the
     // fieldname _studentAdapter
{
    get { return _studentAdapter;
    }
}
   public MultiTier.StudentDataTable GetData() {
     return Adapter.GetData(); // this is the GetData method of the TableAdapter
    // it returns a MultiTier.StudentDataTable
   }
} // end class
```

At this point, there is no business logic, but for now, we will move on to the presentation layer.

If you do not have a Web folder, create one, and add a new Web form to this folder and switch to Design View. Drag in an instance of the ObjectDataSource from the toolbar, and click on the SmartTag and choose Configure Data Source. The dropdown list will likely only show the TableAdapters in the Typed Data Set (our Data Access Layer) and will not show the Business Object classes. To enable these to show up in the drop list, we will modify our previous code in the Business Logic layer by adding DataObject attributes as follows;

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;
using MultiTierTableAdapters;

[System.ComponentModel.DataObject]
public class StudentBLL {
       private StudentTableAdapter _studentAdapter = null;
    public StudentTableAdapter Adapter
{
    get { return _studentAdapter;
    }
}
   public MultiTier.StudentDataTable GetData() {
     return Adapter.GetData();
   }
} // end class
```

Adding the DataObject attribute to the class enables the class to show up in the dropdown list – now if we come back to the Configure Data Source, we will see the Business Logic – choose this and then on the next screen you can choose the method, in this case GetData (since we only have one). and click through to Finish.

This will add code such as the following to your web page:

```
<asp:ObjectDataSource ID="ObjectDataSource1" runat="server"
        OldValuesParameterFormatString="original_{0}" SelectMethod="GetData"
        TypeName="StudentBLL"></asp:ObjectDataSource>
```

where StudentBLL is the name of the class and GetData the method in this class.

Adding a Data Web Control and Binding it to the ObjectDataSource – Add a GridView and from its Smart Tag, choose the ObjectDataSource added just now. Right click on the page and choose View in Browser. You will likely get an NullReferenceException saying that the object reference is not set to an instance of an object, concerning the following two lines:

```
public MultiTier.StudentDataTable GetData() {
        return Adapter.GetData(); }
```

The problem seems to be that we have never created the StudentTableAdapter object. To remedy this, we can test to see if the value is null, and if so, call the constructor to create the object, as shown in the following code (as shown in the Mitchell tutorial). If one makes this change, the data should now display in the page and thus we have a simple, three-tier application although there are no validation rules yet in the data access or business logic layers.

Student.cs (in the App_Code/BLL folder)

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;
using MultiTierTableAdapters;

[System.ComponentModel.DataObject]
public class StudentBLL {
       private StudentTableAdapter _studentAdapter = null;
    public StudentTableAdapter Adapter
{
    get
    {
        if (_studentAdapter == null) _studentAdapter = new StudentTableAdapter();
        return _studentAdapter;
    }
}
   public MultiTier.StudentDataTable GetData() {
     return Adapter.GetData();
   }
} // end class
```

SimpleDisplay.aspx (presentation layer)

The ObjectDataSource TypeName attribute is set equal to StudentBLL, the class in the BusinessLogic Layer and the SelectMethod attribute is set equal to GetData which Is the name of the method that returns a DataTable.

```
<asp:ObjectDataSource ID="ObjectDataSource1" runat="server"
        OldValuesParameterFormatString="original_{0}" SelectMethod="GetData"
        TypeName="StudentBLL"></asp:ObjectDataSource>
    <div>

        <asp:GridView ID="GridView1" runat="server" AutoGenerateColumns="False"
            DataKeyNames="id" DataSourceID="ObjectDataSource1">
            <Columns>
                <asp:BoundField DataField="id" HeaderText="id" InsertVisible="False"
                    ReadOnly="True" SortExpression="id" />
                <asp:BoundField DataField="student" HeaderText="student"
                    SortExpression="student" />
                <asp:BoundField DataField="score" HeaderText="score"
SortExpression="score" />
            </Columns>
        </asp:GridView>

    </div>
```

Multitier.xsd (in App_Code/DataAccess folder)

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:mstns="http://tempuri.org/MultiTier.xsd" xmlns="http://tempuri.org/MultiTier.xsd"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:msdata="urn:schemas-microsoft-com:xml-
msdata" xmlns:msprop="urn:schemas-microsoft-com:xml-msprop"
targetNamespace="http://tempuri.org/MultiTier.xsd" elementFormDefault="qualified"
attributeFormDefault="qualified" id="MultiTier">
        <xs:annotation>
                <xs:appinfo source="urn:schemas-microsoft-com:xml-msdatasource">
                        <DataSource DefaultConnectionIndex="0"
FunctionsComponentName="QueriesTableAdapter" Modifier="AutoLayout, AnsiClass, Class, Public"
SchemaSerializationMode="IncludeSchema" xmlns="urn:schemas-microsoft-com:xml-msdatasource">
                                <Connections>
                                        <Connection AppSettingsObjectName="Web.config"
AppSettingsPropertyName="multitierConnectionString" ConnectionStringObject=""
IsAppSettingsProperty="true" Modifier="Assembly" Name="multitierConnectionString (Web.config)"
ParameterPrefix="@"
PropertyReference="AppConfig.System.Configuration.ConfigurationManager.0.ConnectionStrings.multitie
rConnectionString.ConnectionString" Provider="System.Data.SqlClient"/>
                                </Connections>
                                <Tables>
                                        <TableAdapter
BaseClass="System.ComponentModel.Component" DataAccessorModifier="AutoLayout, AnsiClass,
Class, Public" DataAccessorName="StudentTableAdapter"
GeneratorDataComponentClassName="StudentTableAdapter" Name="Student"
UserDataComponentName="StudentTableAdapter">
```

```
                                        <MainSource>
                                             <DbSource
ConnectionRef="multitierConnectionString (Web.config)" DbObjectName="dbo.Student"
DbObjectType="Table" GenerateMethods="Get" GenerateShortCommands="false"
GeneratorGetMethodName="GetData" GetMethodModifier="Public" GetMethodName="GetData"
QueryType="Rowset" ScalarCallRetval="System.Object, mscorlib, Version=4.0.0.0, Culture=neutral,
PublicKeyToken=b77a5c561934e089" UseOptimisticConcurrency="false"
UserGetMethodName="GetData" UserSourceName="GetData">
                                                  <DeleteCommand>
                                                       <DbCommand
CommandType="Text" ModifiedByUser="false">

     <CommandText>DELETE FROM [Student] WHERE (([id] = @Original_id))</CommandText>
                                                            <Parameters>
                                                                 <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="Int32" Direction="Input"
ParameterName="@Original_id" Precision="0" ProviderType="Int" Scale="0" Size="0"
SourceColumn="id" SourceColumnNullMapping="false" SourceVersion="Original"/>
                                                            </Parameters>
                                                       </DbCommand>
                                                  </DeleteCommand>
                                                  <InsertCommand>
                                                       <DbCommand
CommandType="Text" ModifiedByUser="false">

     <CommandText>INSERT INTO [Student] ([student], [score]) VALUES (@student,
@score)</CommandText>
                                                            <Parameters>
                                                                 <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="AnsiString" Direction="Input"
ParameterName="@student" Precision="0" ProviderType="VarChar" Scale="0" Size="0"
SourceColumn="student" SourceColumnNullMapping="false" SourceVersion="Current"/>
                                                                 <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="Int32" Direction="Input"
ParameterName="@score" Precision="0" ProviderType="Int" Scale="0" Size="0" SourceColumn="score"
SourceColumnNullMapping="false" SourceVersion="Current"/>
                                                            </Parameters>
                                                       </DbCommand>
                                                  </InsertCommand>
                                                  <SelectCommand>
                                                       <DbCommand
CommandType="Text" ModifiedByUser="true">

     <CommandText>SELECT     Student.*
FROM          Student</CommandText>
                                                            <Parameters/>
                                                       </DbCommand>
                                                  </SelectCommand>
                                                  <UpdateCommand>
                                                       <DbCommand
CommandType="Text" ModifiedByUser="false">

     <CommandText>UPDATE [Student] SET [student] = @student, [score] = @score WHERE (([id] =
@Original_id))</CommandText>
                                                            <Parameters>
```

```
                                            <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="AnsiString" Direction="Input"
ParameterName="@student" Precision="0" ProviderType="VarChar" Scale="0" Size="0"
SourceColumn="student" SourceColumnNullMapping="false" SourceVersion="Current"/>
                                            <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="Int32" Direction="Input"
ParameterName="@score" Precision="0" ProviderType="Int" Scale="0" Size="0" SourceColumn="score"
SourceColumnNullMapping="false" SourceVersion="Current"/>
                                            <Parameter
AllowDbNull="false" AutogeneratedName="" DataSourceName="" DbType="Int32" Direction="Input"
ParameterName="@Original_id" Precision="0" ProviderType="Int" Scale="0" Size="0"
SourceColumn="id" SourceColumnNullMapping="false" SourceVersion="Original"/>
                                        </Parameters>
                                    </DbCommand>
                                </UpdateCommand>
                            </DbSource>
                        </MainSource>
                        <Mappings>
                            <Mapping SourceColumn="id"
DataSetColumn="id"/>
                            <Mapping SourceColumn="student"
DataSetColumn="student"/>
                            <Mapping SourceColumn="score"
DataSetColumn="score"/>
                        </Mappings>
                        <Sources/>
                    </TableAdapter>
                </Tables>
                <Sources/>
            </DataSource>
        </xs:appinfo>
    </xs:annotation>
    <xs:element name="MultiTier" msdata:IsDataSet="true" msdata:UseCurrentLocale="true"
msprop:Generator_UserDSName="MultiTier" msprop:Generator_DataSetName="MultiTier">
        <xs:complexType>
            <xs:choice minOccurs="0" maxOccurs="unbounded">
                <xs:element name="Student"
msprop:Generator_TableClassName="StudentDataTable"
msprop:Generator_TableVarName="tableStudent" msprop:Generator_TablePropName="Student"
msprop:Generator_RowDeletingName="StudentRowDeleting"
msprop:Generator_UserTableName="Student"
msprop:Generator_RowChangingName="StudentRowChanging"
msprop:Generator_RowEvHandlerName="StudentRowChangeEventHandler"
msprop:Generator_RowDeletedName="StudentRowDeleted"
msprop:Generator_RowEvArgName="StudentRowChangeEvent"
msprop:Generator_RowChangedName="StudentRowChanged"
msprop:Generator_RowClassName="StudentRow">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="id" type="xs:int"
msdata:ReadOnly="true" msdata:AutoIncrement="true" msdata:AutoIncrementSeed="-1"
msdata:AutoIncrementStep="-1" msprop:Generator_ColumnVarNameInTable="columnid"
msprop:Generator_ColumnPropNameInRow="id"
msprop:Generator_ColumnPropNameInTable="idColumn" msprop:Generator_UserColumnName="id"/>
                            <xs:element name="student"
msprop:Generator_ColumnVarNameInTable="columnstudent"
```

```
msprop:Generator_ColumnPropNameInRow="student"
msprop:Generator_ColumnPropNameInTable="studentColumn"
msprop:Generator_UserColumnName="student">
                                                    <xs:simpleType>
                                                         <xs:restriction base="xs:string">
                                                              <xs:maxLength
value="50"/>
                                                         </xs:restriction>
                                                    </xs:simpleType>
                                               </xs:element>
                                               <xs:element name="score" type="xs:int"
msprop:Generator_ColumnVarNameInTable="columnscore"
msprop:Generator_ColumnPropNameInRow="score"
msprop:Generator_ColumnPropNameInTable="scoreColumn"
msprop:Generator_UserColumnName="score"/>
                                          </xs:sequence>
                                     </xs:complexType>
                                </xs:element>
                           </xs:choice>
                      </xs:complexType>
                      <xs:unique name="Constraint1" msdata:PrimaryKey="true">
                           <xs:selector xpath=".//mstns:Student"/>
                           <xs:field xpath="mstns:id"/>
                      </xs:unique>
                 </xs:element>
</xs:schema>
```

References

ASP.NET 4 Unleashed by Stephen Walther, Kevin Hoffman, Nate Dudek , SAMS, 2011, pp 757-770, 833-912

Pro C# and the .NET Platform by Andrew Troelsen, Apress, 2010, pp. 825-950

Tutorial 1:Creating a Data Access Layer, Scott Mitchell, June 2006 http://msdn.microsoft.com/en-us/library/aa581776.aspx

Tutorial 2: Creating a Business Logic Layer, Scott Mitchell, June 2006, at http://msdn.microsoft.com/en-us/library/aa581779.aspx

Tutorial 4: Displaying Data with the ObjectDataSource, Scott Mitchell, June 2006 at http://msdn.microsoft.com/en-us/library/aa581783.aspx