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An Analysis of Public Education Informatics

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AN ANALYSIS OF PUBLIC EDUCATION INFORMATICS

A Capstone Experience/Thesis Project

Presented in Partial Fulfillment of the Requirements for

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Honors College Graduate Distinction at Western Kentucky University

By

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ABSTRACT

Information systems and informatics technologies are employed to increase profitability and efficiency of business models. The most common mistake made by managers, when incorporating informatics into their business model, is under-utilizing the technological capacity of their resources and investing in extraneous functions. This thesis will examine the usage of information systems and informatics principles in the United States public education system. Approaching the case from a consultant's perspective, this paper will map out the business model theory, its actual implementation, and identify key failure points and areas of improvement in informatics usage. The structure of the thesis follows the first 2 steps of ADDIE Instructional Design model, embedded within the strategic management business analysis model. It begins with the business analysis, then systems analysis, followed by design of the informatics structure that would best suit the needs of the Public Education System. The results are then compared with the current solutions and a conclusion on necessary migration and improvements are made.

Keywords: Informatics, Public Education, Business Analysis, Educational Technology, Instructional Design, Information Systems

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FIELDS OF STUDY

Major: Business Informatics

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CHAPTER 1

INTRODUCTION

The Public Education System has been the punching bag of many pundits, scholars, and researchers over the years for its regular international underperformance. In the wake of No Child Left Behind and the slew of assessments that followed, there is a willingness to invest in Education yet uncertainty on how to do so. The ideas behind this paper come from a business analyst's position and are meant to function as recommendations for how to improve the informatics within the system.

Informatics are tools that collect, manage, and respond to information. The fact that we are exploring investment options without understanding the full scope of the problem points to a mismanagement of information. To be more forward, how can we respond to a situation regarding urban graduation rates if we don't know the types of learners that are most likely to fail? How can we invest in more assessments if we don't have information on whether or not students are encouraged by tests themselves? Open-ended questions aside, there are constraints on what can and cannot be addressed with informatics usage.

Oftentimes firms and organizations can focus too much on collecting any information they can and much of it goes to waste. Given the thin leeway schools have with budgets and funds, such actions would be a waste of useful resources. Useful

information pertains directly to the operational and administrative functions of a company. This can range from tracking a process with advanced statistical controls to providing decision support when building social teams of individuals. In order to identify where and how successful informatics can be implemented, a business analysis is necessary.

The purpose of this capstone experience project is to perform a business and systems analysis of the public education system. A business analysis examines the operating environment of an organization (Legal and Industry Standards). These are correlated with the ability to carry out the mission of the firm to identify areas of improvement. The analysis will then be followed by design recommendations and developed modules that will function as proof-of-concept solutions. These steps will be in accordance with the ADDIE (Analyze, Design, Develop, Implement, Evaluate) Instructional Design model, so that the results will carry practical value for real-world implementation, not just as an academic notion.

CHAPTER 2

ANALYSIS OF BUSINESS MODEL

1. Business Analysis

    a. Legal Bounds

The primary function of the U.S. public education system is to meet the requirements set by each state's Department of Education. For this analysis, the standards set by Kentucky's Department of Education for secondary schools are used as the benchmark. It can be assumed all standards are currently met, as public schools are currently operating. However, the standards need to be kept if and when the redesign workflow and systems processes occur. These requirements are set forth by Kentucky Administrative Regulation 3:305 and include controls over what must be taught in order for graduation. There are two varying curriculums, one of which provides the standards for graduation and the other provides standards for post-secondary education preparation requirements (Minimum Requirements for High School Graduation, 2005).

The standards are as follows:

- 4 credits of Language Arts
- 3 credits of Social Studies
- 3 credits of Mathematics
- 3 credits of Science

- ½ credit of Health
- ½ credit of Physical Education
- 1 credit of Arts
- 7 credits of electives
- 2 credits of World Language
    - Only necessary for post-secondary preparation curriculum.

This culminates into a maximum of 24 credit hours required for graduation and entry to a post-secondary institution. However, a majority of high schools supplement these courses with opportunities for advanced, extracurricular, and/or optional activities. For instance, South Oldham High School in Oldham County offers a total of 28 possible credits, 7 per year. This allows for Dual-Credit courses, Co-op opportunities and response to dynamic events. These dynamic events can include failed courses, additional regulations being imposed, or any other extenuating circumstances that would require earning additional credits.

Because of this, planning for additional legal regulations is problematic. Kentucky's Department of Education delegates curriculum and program regulation to county-level Boards of Education. In several instances, these Boards may even delegate further to school or campus level Site Based Decision Making Councils, or otherwise ("Oldham county high," 2005). For this reason, there are hundreds of sets of standards for the state of Kentucky alone. The standards set by these administrative bodies can define anything from acceptable world history homework to Gifted and Talented course augmentation. Any effective business model must incorporate reasonable flexibility for each school to adapt to its operating environment.

b. Industry Standards

After the legal regulations are taken into account, industry standards are of the next most importance. However, since the public education system is essentially a government monopoly, there aren't many to speak of. Outside the monopoly is the distant competition of foreign school systems and private schools. The closest match to an industry standards association is the PISA, Program for International Student Assessment. This test measures the abilities of 15 year olds in the areas of reading literacy, science, and mathematics. The test is conducted every three years and is utilized by many countries to benchmark their educational performance ("Frequently asked questions," 2006). Alternatively, there is the TIMSS, Trends in International Mathematics and Science Study, which is conducted on a 4 year cycle ("Trends in international," 2003).

The 2009 PISA results are the latest released, which place the United States at 33 points, 7%, below top-scoring countries in reading and 50 points, 10%, below top-scoring countries in mathematics ("Highlights from pisa 2009," 2010). Such results are what promote industry shifting initiatives, like Race to the Top and No Child Left Behind. However, there is some discrepancy over the relevancy of the test scores. Recent studies by the Stanford Graduate School of Education and the Economic Policy Institute have found that the PISA results are skewed negatively against the United States (Carnoy & Rothstein, 2013). In this study, the scores presented in the 2009 report were broken down according to social class. Since there is a known correlation between social class and educational ability, the distributions of these social classes among PISA participants is important when factoring the results. The study found that the United States has large proportions of low-class individuals taking the PISA, relative to other countries. When

the scores are weighted to account for the distribution of scores and the U.S. is positioned against nations with similar economic standing, it places much higher in all social classes. Additionally, the discrepancy between social classes is significantly lower compared to other countries.

Overall, these results indicate that the United States public education system is making fair use of budgeted funds for education, relative to other countries. There are similar results for the TMISS, when the scores are weighted and re-calculated (Carnoy & Rothstein, 2013). The U.S. still falls short of top-scoring countries (Hong Kong, Finland, and others); however these countries have a much higher emphasis of education. Typically, such results stem from private investment in tutors, cram schools, and special training programs. These factors can come into play when constructing the business model.

With regards to these findings within the PISA, a competitive model for education would allow students the ability to have advanced and extra-curricular study in the areas of reading, mathematics, and science. It needs not be integrated into the school day itself, but focusing on a reduced cost method of providing such activities would be beneficial to maintaining a high-level of industry excellence.

c. Mission Statement

After the legal requirements of operation, the functional requirements as dictated by the mission statement and theory from the field give the model its shape. Since each and every school, board of education, and regulatory committee has a unique mission statement, a look at the aggregate similarities and the state-wide objectives will serve for

business model construction. The mission statement for the Kentucky Department of Education ("Kentucky board of," 2012) is as follows,

> *"The Kentucky Department of Education's mission is to prepare all Kentucky students for next-generation learning, work and citizenship by engaging schools, districts, families and communities through excellent leadership, service and support."*

This mission statement can be broken in three distinct parts: the goal of preparation for learning, work and citizenship; the method of engaging districts, families, and communities; and the medium of excellent leadership, service, and support. While this mission statement doesn't pertain to any one individual school, it has serious implications for the functions each school must perform.

The facilitation of leadership and service implies a congruous organization among schools. This means that organizational positions and hierarchies must be very similar. If one school is orchestrated on the basis of grade level (i.e. Department of 9^{th} Grade, 10^{th} Grade, etc.), while another school has a subject based system (i.e. Department of English, Department of History, etc.), then enforcing leadership between communities will be very difficult. The problem progresses further when considering the transferring of students and the hiring/firing of faculty and staff. The option of support between schools leans towards a modular construction. The schools together form a larger system, into which schools can be added or removed with little harm to the system itself. Human resources and capital between units would ideally be interchangeable. While at first, this part of the mission statement may seem innocuous, it is certainly very demanding of responsible business model design practices.

On top of this physical design are the functions of interaction with the service's consumers, or users. The schools must be "engaged" in efforts of leadership, service and support, in order to facilitate next-generation learning, work, and citizenship. In practical terms, this means the school must be a proactive support service organization which produces measurable results in citizenship, learning, and work. Measurement is the key word here. There must be an objective measurement for these factors, so that way leadership and service can be maintained. None of these concepts are necessarily objective in nature, which can make the objective tracking difficult.

The Department of United States Citizenship and Immigration Services divides the test for citizenship into four sections: Speaking, Reading, Writing, and Civics ("Civics (history and," 2011). Considering the school curriculum requirements in Chapter 2.1.a of this paper, the first three will be covered by the current standards. The final selection of civics is composed of history, law, geography, and common social practices. Much of this information is covered over a variety of courses from primary education (social studies) to secondary school (U.S. History). However, there are no concrete grades of citizenship distributed on report cards in individual schools, nor assessed on the state level. These measures need to be developed and implemented.

Learning is something that can be measured using contemporary learning psychology and traditional assessments. The goal of the process should be comprehension of the concepts required by the Department of Education, as determined by standard assessment. Other statistical process controls (standard deviation, progress points, etc.) can be determined with contemporary learning theory. This process will be discussed more in the systems design application, as that's where it mainly applies.

Finally, there is an affinity and efficacy for work. This is yet another multi-dimensional and evolving concept. The work-force of the 21st century service-information economy is nothing like any before. It requires a curriculum that is open to the rapid advances technology makes upon the employment requirements worldwide. Commonly referred to as "The Four C's", these skills include: critical thinking, communication, collaboration, and creativity ("An educator's guide," 2010). Unlike the skills of the 20st century (reading, writing, and arithmetic), these cannot be directly taught in the classroom as part of a lecture or worksheet exercise. Since they are methods of approaching problems, they need to be orchestrated into the learning environment itself. The method of discerning these principles will be covered in the systems design structure, as that is where the information will be collected and analyzed.

d. Competitive Advantage

After outlining the requirements of the business model, it is typical practice to focus on the elements that will help breed a competitive advantage for the organization. Given that schools aren't in direct competition, the extent to which this applies is subjective. For the nature of this paper, the model will at least approximate various venues that could be applied for competitive advantage and be sure to facilitate those requirements.

As population increases and the number of schools increases, specialization becomes more likely –which will be determined by competitive advantage. In order to allow for innovation on this scale, the systems need to be able to identify areas of specialization and report trends towards that segmentation, as they arise. This will allow

administrative officials to focus on areas that will capitalize on these trends. In schools today, common areas of specialization are Mathematics & Science, such as the Gatton Academy of Math & Science, and the Arts, such as performing arts schools. Both of these can be tracked and managed by gauging relationships between relative success in the respective subject areas, as well as the development of a financial and social environment suitable for the shift.

Another area of competitive advantage is in fundraising. Through partnerships with community businesses, parents, and student, many schools are able to raise considerably more funds than others for various projects. Schools with an advantage in this area will want to invest in community outreach programs ("Five fundraising tactics," 2009), like an app for making donations or attending school events. The systems will need to compare the donations with the average results for other schools within the county and state to determine whether further investment in these practices would produce high returns.

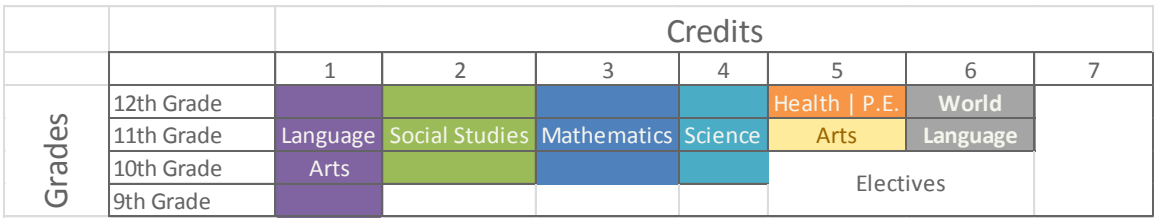
Finally, there is the area of course content logistics. Web-based technologies allow for additional adaptation to student needs. Courses in this realm can be easily altered and tailored for individual students, as the content is not delivered to an aggregate population, but to individual users. These schools can target determined students with unique interests, such as architecture or archaeology. This also provides classroom freedom for students to go on more field trips, invite guest speakers, and gamification. This requires significantly more management than the current learning environment, so this will likely be specific to a school as a competitive advantage.

By preparing for these three possibilities, the system will be creating a responsible and lasting environment for institutions to flourish. All specializations, as a matter of principle, lead to higher return on investment and competition. Recognized as necessary tools for success in the private world, such a system will allow these advantages to apply to the public realm as well. All without violating any of the integrity or administrative oversight required in the public sector.

2. Business Model

a. Production Map (**Figure 2.1**)

This figure outlines the production areas of a high school, per the legal requirements. On the Y axis are the grades, the X axis holds the credits in a year. This visual allows for conclusions to be drawn and easily communicated.



Conclusions drawn from this mapping:

- Language Arts credit mandated every year. Failure will require special action by administration, since it necessitates additional years of attendance.
- Failure in any required subject reduces electives by 1.

- Required courses should be distributed towards earlier years, for possibility of failure and remediation.

b. Organization Chart (**Figure 2.2**)

This outlines the organization along the traditional focus of departments and functions. Such charts are used to demonstrate human resource needs, build task-forces, and to delegate responsibilities. They also focus the roles of employees so they can perform their tasks more efficiently

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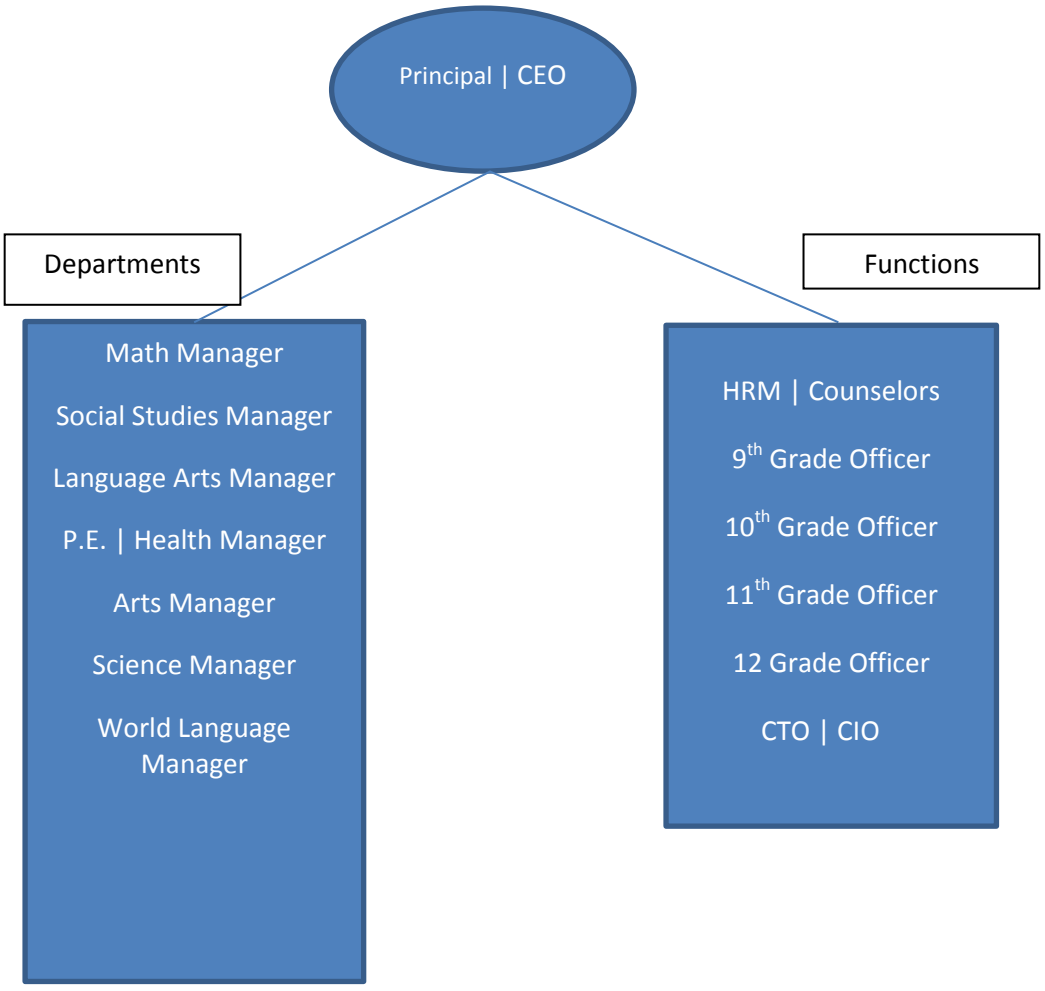
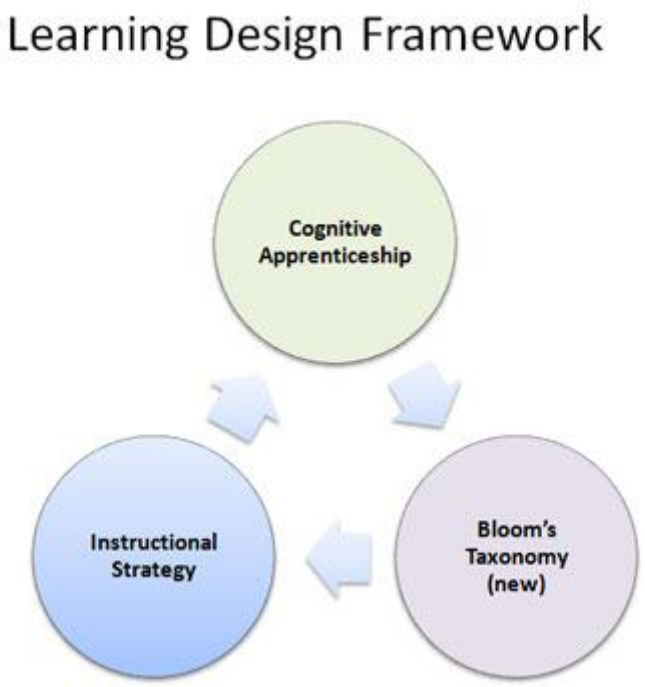


Conclusions drawn from this mapping:

- Matrix structure required, preferably Strong/Project Matrix, due to product focus
- CEO will need to focus on financial considerations, as costs can be increased in project matrix structures
- Counselors should be separated by grade level, to coincide with other functional level positions

c. Process Map (**Figure 2.3 ISD Model**)



The figure above illustrates a common implementation of the Instructional Systems Design Framework (Clark, 2010). Cognitive apprenticeship works along the lines of teacher-student interaction and can determine the level of involvement for the instructor. This helps to keep the student engaged within Vygotsky's Zone of Proximal Development. By having the right layout of checks and balances in information usage, this cycle insures integrity in the system. Bloom's Taxonomy dictates what to present and records progress, the Instructional Strategy delivers the content, and Cognitive Apprenticeship manages hints, tooltips, and other peripherals.

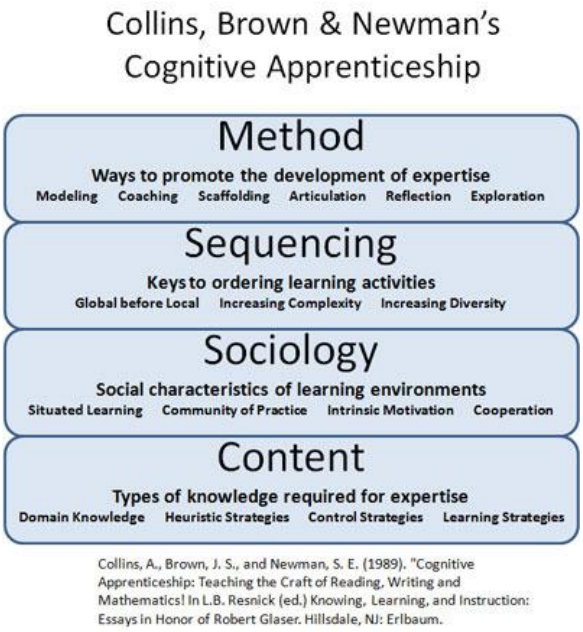


Figure 2.4 Cognitive Apprenticeship

Bloom's Taxonomy works on the cognitive level, balancing the social-constructivist focus of Cognitive Apprenticeship. It measures learning performance along a linear progression and can be extended to determine which question types are fit for learning progressions. Using the relationships between these function, Domains

of Knowledge were established to show what type of individual results from proficiency at various levels.

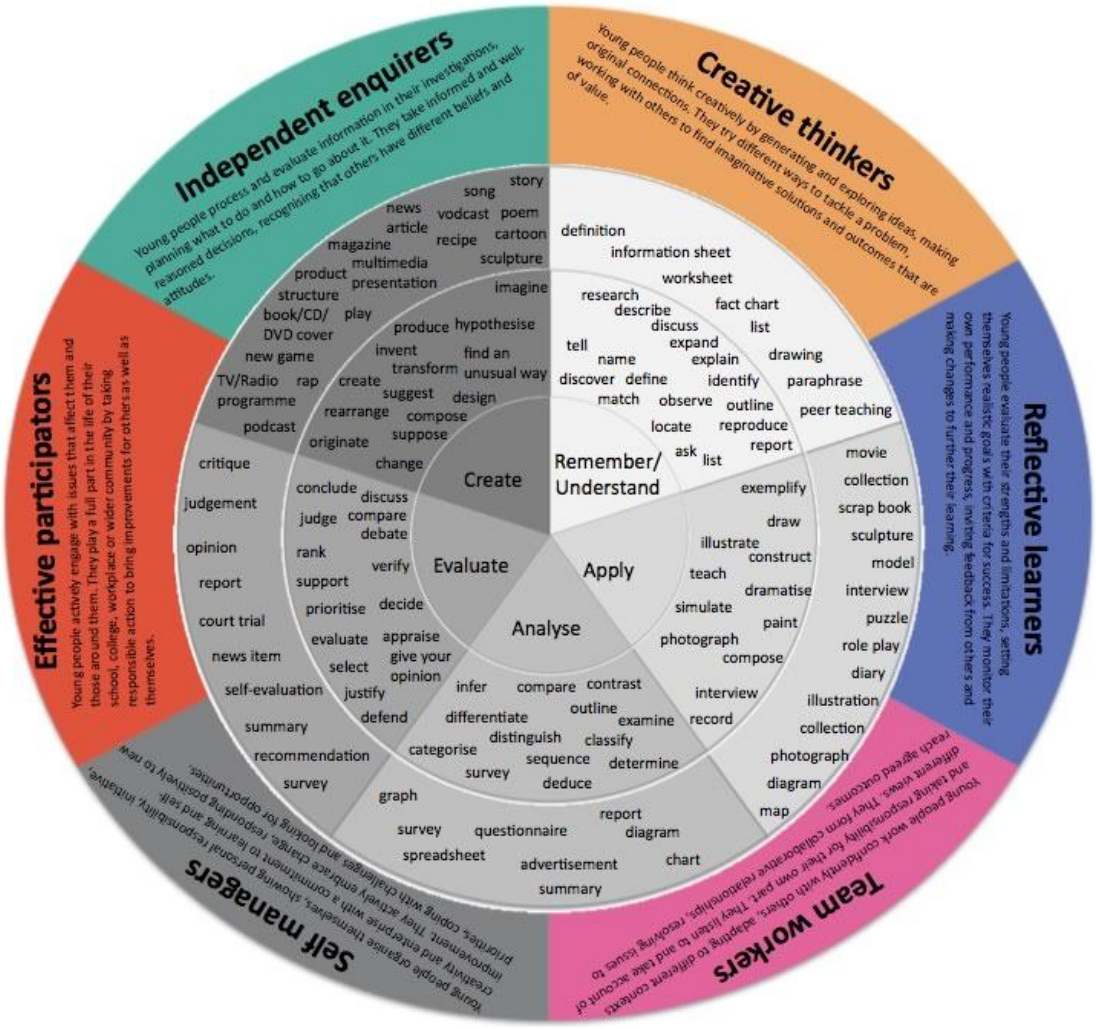


Figure 2.5 Bloom's Taxonomy

The process mapping provided here is constructed to be universally applicable to all subject areas. This way, results can be measured and benchmarked across various subject areas with regards to effectiveness and execution. The method to instruct will be determined, and then sequenced according to Bloom's Taxonomy, the social characteristics will be determined by the system, and then content will be delivered in a measurable fashion.

CHAPTER 3

LOGICAL SYSTEMS DESIGN

1. Role in Business Model
    a. Operations Control

The role of the systems within the business model from Chapter 2 will be to provide measurable feedback on processes and organizational controls. It will need to provide measures on both the organizational and functional level, as well as control individual process units. The former issue can be handled by providing a database with multiple views into the content, one from each organizational perspective. For example, 9th grade managers will have access to a view that shows the aggregate 9th grade results for progress in various departments, classes, and social paradigms.

With concerns for lean operations, scalability, and adaptability, the database would be coded in MySQL, or one of its variants. This is a common database program language which is open-source, meaning not proprietary, and provides a wealth of opportunities from web-app access to automated report generation. Such reports will need to determine the mean output, with regards to assessment and GPA scores, identify the outliers, and recommend solutions.

Student data can be recorded by entries from instructor client-side applications. These applications will report information back to the database, retrieve the updated standards, and then generate the suggested content for the student. For instance, if the

student is learning factorization in an algebra course and is currently in the Apply Phase of Bloom's Taxonomy, the program will deliver content which fits that phase of learning. In this example, the student could construct a factor diagram. Since the Kentucky Department of Education is currently building a database of questions and evaluations, this program could easily query it for content that fits the student's needs. This provides the customized and guided process control needed for a responsible system, capable of guiding trends in student progress.

b. Human Resource Management

Typical Human Resource Management practices are reserved for firm employees and inter-organizational entities. In this case, however, schools have an interest in the social well-being of the student's for accomplishing their long-term goals. The goals of citizenship and the ability for students to enter a modern workforce are two examples. HRM practices focus on creating environments in which the individuals within can thrive and create a symbiotic social culture. The only real social controls the school has are those of classroom management and establishing an organizational culture.

Classrooms need to be optimized for social progress. This means grouping students together who are likely to complement and supplement each other, along the learning process. For this kind of team-building, HR Manager's often turn to personality and skill tests. After identifying the personalities and skills, the participants are then placed into groups which have agreeable personalities and differing skills. There are some major constraints on this process within the Public Education System, however. Many schools have thousands of students with evolving and changing personalities and skillsets are constantly increasing in range. To combat these issues, the personalities can

be measured along the MBTI standard and incorporated into decision modeling optimization software, which can react to changing information instantaneously.

The Myers-Briggs Type Indicator identifies individuals on a 4 point basis, translated as a four letter code (e.g. “INTJ”) (Briggs Meyers, McCaulley, Quenk & Hammer, 1998). Each letter stands for a personality trait, such as I for introverted or J for judgmental. This particular personality test is well-documented in the field of psychology and often used in HRM practices for hiring and team-building. Moreover, the studies in recent years have expanded to provide profiles for each of the 16 types that indicate viable group members, career developments, and problem solving pitfalls. All of these areas can be of great use in a system to provide an optimal social environment.

The personality types each have a complement, supplement, and advisor ("Typelogic - pairs," 2010). This refers to the ways in which they commonly interact with each other. When grouped together, they form a 4 type ring in which all members have at least two supporting elements. This turns the 16 personality types into 4 blocks which provide and optimum social environment. The example provided below has 4 types with their relationships and popular careers in brackets (Hzlotow, 2009).

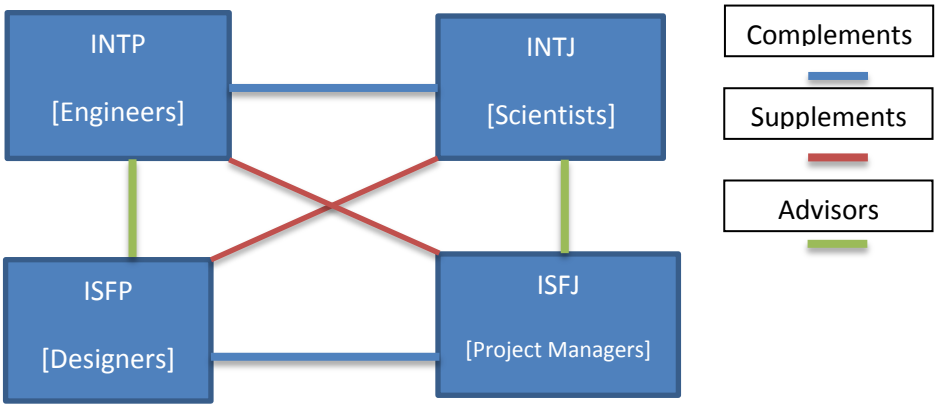


Figure 3.1 MBTI Type Relationship Block

When you combine the four above, you find that you have the foundations for a research group. The designer provides the framework for research, and then the engineers and scientists conduct research, supervised by the project managers. This does not seem to be a coincidence, as the other 3 blocks form other sectors of the labor force. They are displayed in the table below:

Figure 3.2 Table of MBTI Block

Research Block	INTP [Engineers]	INTJ [Scientists]	ISFP [Designer]	ISFJ [Project Managers]
Private Sector Block	ENTJ [CEO]	ENTP [Entrepreneur]	ESFP [Sales]	ESFJ [Human Resources]
Public Sector Block	ESTJ [Police Officer]	ESTP [Paramedic]	ENFP [Teacher]	ENFJ [Social Worker]
Support Block	INFP [Lawyers]	INFJ [Doctors]	ISTP [Mechanics]	ISTJ [Judges]

Class rosters can be constructed in order to maximize the integrity of these four blocks, which should directly help with social wellbeing and accomplishment. Indirectly, the experience of working alongside the same types of people they are likely to be connected with in the work force is a notable advantage in preparation. The relative success of these fields can also be triggered to notify when various specializations are available. For instance, if your Private Sector Block is doing much better than other areas, then adding business preparatory courses could help reign in outliers and draw in top-performers.

c. Marketing

The schools are held responsible for engaging and maintaining positive relationships with students, parents, and the community. In order to do this, capitalizing on Web 2.0 technologies is paramount. With respect to those technologies, information sharing and advertising must be measurable and agile. This presents an issue, given that the current systems design utilizes SQL-based database technology. While efficient at maintaining the relationships between records, SQL doesn't scale well when considering frequent mobile access and the aggregation of millions of records country-wide. For these issues, Google and Amazon have pioneered the realm of noSQL, which allows for these functions (Finley, 2012).

NoSQL is a non-relational database that allows many users to quickly access and retrieves just the pieces of information they need. They allow you to add values and columns quickly and efficiently, without having to re-index an entire table of records. Popular noSQL languages include MongoDB and CouchDB, which each utilize JavaScript Object Notation (JSON) to store records. This has similar advantages to SQL, as it is open-source and recognizable on all platforms (including smart-phones). While there has been much dispute over whether noSQL or SQL is a better database structure, there is no reason not to make use of both.

By adding an interactive noSQL database that pulls from the SQL records, you can create a client-side server that can handle the requests and queries from web-apps, smartphones, students, parents, organizations, etc. With noSQL powering the client-side database, a variety of high-traffic marketing campaigns are available, without risking

server or record security. Marketing strategies can then be customized and implemented to fit the target market within the area. All schools should consider their markets as a function of three groups, with respect to the various goals of a marketing campaign. These groups are students, parents, and community organizations.

Students form the product group. Engaging and maintaining a positive educational relationship will help encourage academic participation. In order to do this, educative games, push surveys, and challenges can be delivered via any number of methods available. These methods may be email, mobile app, text, or even through some other means yet to be developed. The open-source nature of the design allows for these functions to easily plugin and integrate to the existing systems.

Parents form the fundraising and leadership group. Parents are often responsible for contributing to the extra-curricular committees and teams within a school. By engaging the parents through a marketing campaign, consumer relations can be managed in a way that tracks parent groups that are the most helpful or resourceful. It also allows for predicting at what times of the year parental help shortages can occur, allowing for adequate for planning. This can help prevent cancellation of planned events, which lower morale for the entire student body. By separating parents from the student group, you are giving them a unique role in the educational process. By assuming roles as coordinators and assistants, parents can be fostered into a culture of leadership according to the goals of the Department of Education.

Finally, the community organizations form the resource allocation and capital group. These entities are usually the most capable of delivering high dollar value

contributions from specific activities. Having a sporting goods store sponsor uniforms for the basketball team or a music outlet funding a performance field trip for band members are a couple of benefits that can result from prosperous organizational relationships. These relationships, as all relationships, can be maintained and extended through the use of the consumer relations management capabilities of databases. In order to facilitate all these functions, developing a noSQL database, which mirrors the SQL database, capitalizes on all market segments.

CHAPTER 4

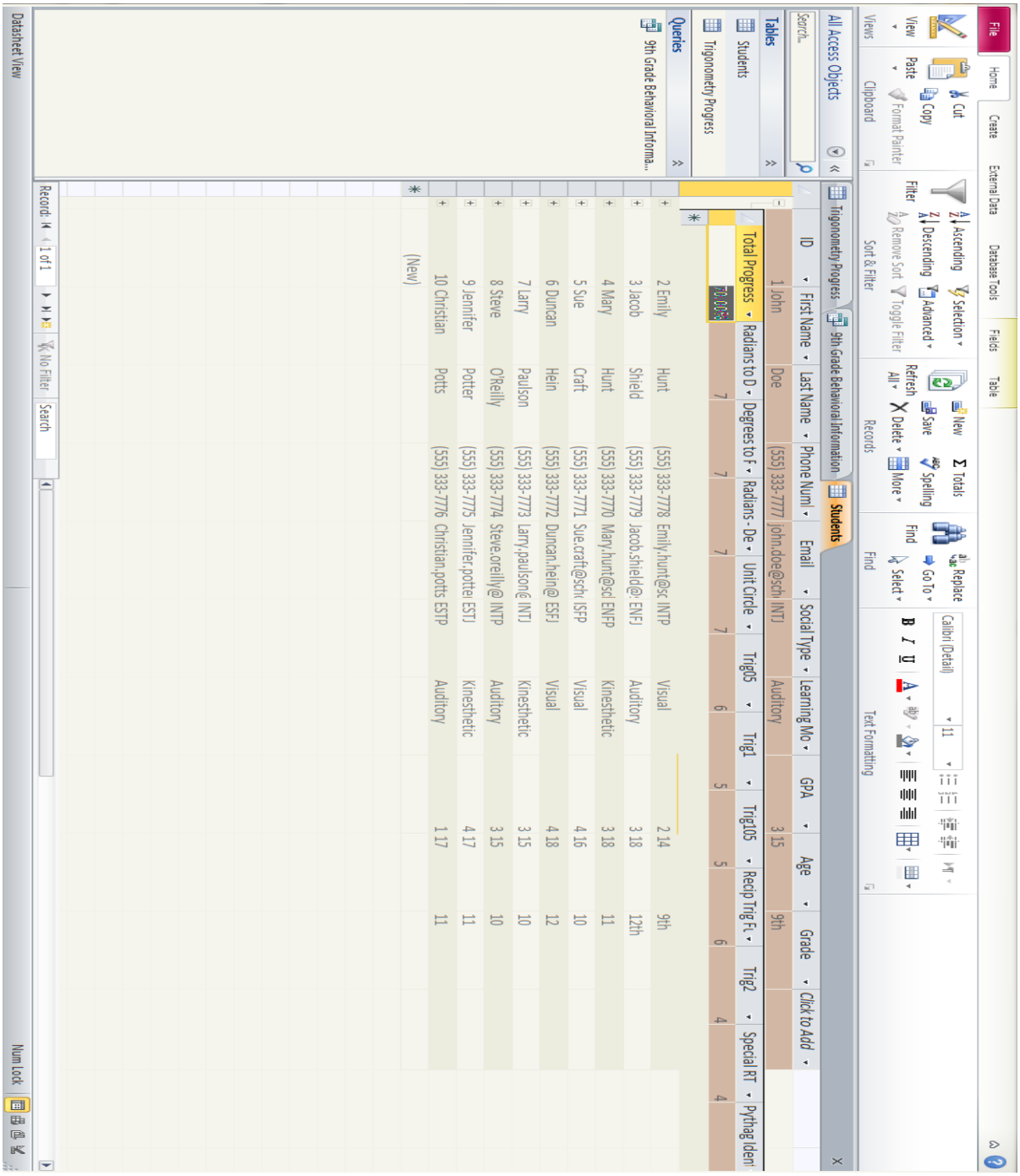
SYSTEMS DEVELOPMENT

The development phase of technology typically requires significant knowledge of and testing on the physical structure of the system. That is, what types of computers, operating systems, network connections, and other tangible elements make up the components of the systems? While exact specifications and testing capabilities are outside the scope of this research paper, there are certain components that are universal.

These components include the student database, MBTI optimization decision model, and content delivery pseudo-code. The student database language and structure is already determined by earlier chapters, namely an SQL and NoSQL implantation that mirror each other. Each database should have student identification records, knowledge map progress tracking, and profile tracking. The MBTI model need only accept an input of students and arrange them accordingly to the best possible configuration for the class size specified. In order to make this model more fertile, able to apply to more schools, the min/max class sizes should be adjustable. Finally, there is the programming model that determines how and when to present individualized content. This can be programmed in pseudo code, a generalized coding language that can be adapted almost universally.

1. Student Databases

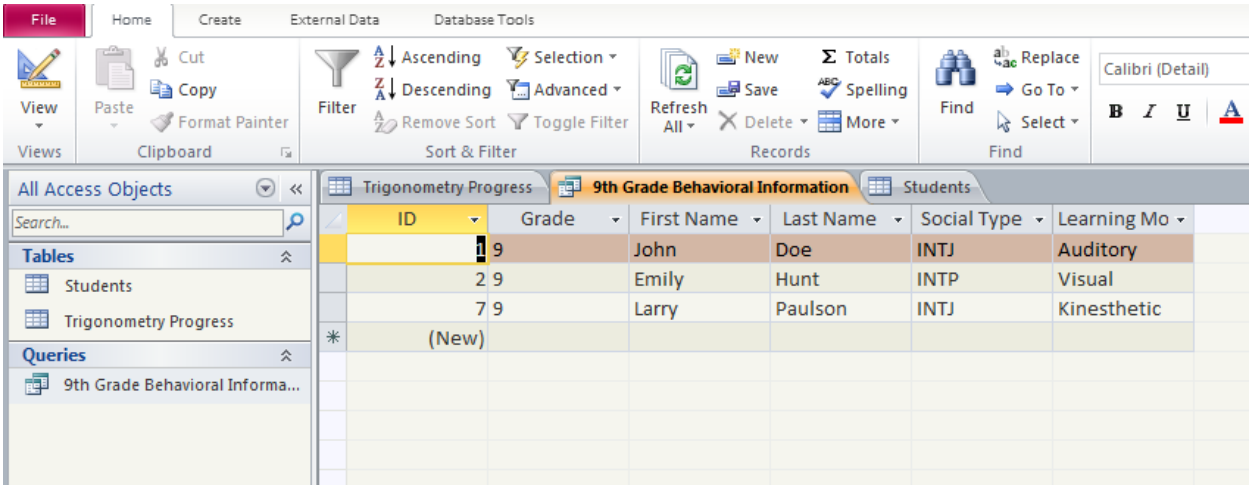
AccessSQL: **Figure 4.1 Access 2010 Database**



Here in the AccessSQL tables you can see that the relational database equates the student information with the table for section progress. One purpose of the SQL database, given from the business analysis, is to allow views on both the departmental and functional components of a student. This allows 9th grade managers to view the entire 9th grade concurrently and pull information, while the Math officers should be able to pull information from the student's math data concurrently.

For this reason, the Trigonometry Progress is its own table, with references to Student ID only. Reports can then be run focused solely on this data, to identify trends and outliers. From the functional perspective, the grade level managers can pull data through queries across the students table.

Figure 4.2 Access 2010 Query



MongoDB – noSQL:

```
> db.students.find()

[
  {   "_id" : {   "$oid" : "5162fcb0cc93742c16046571"   },   "FName" : "John"   },
  {   "LName" : "Doe",   "_id" : {   "$oid" : "5162fcb8cc93742c16046572"   }   },
  {   "_id" : {   "$oid" : "5162fd35cc93742c16046582"   },   "Phone" : "5553337777"   },
  {   "LearningMode" : "Auditory",   "_id" : {   "$oid" : "5162fd60cc93742c16046583"   }   }
]
```

Figure 4.3 noSQL Database

The example above shows the student's database written in MongoDB's noSQL format. This format is known as JSON (Javascript Object Notation), which all web browsers and platforms use. This means that virtually every website and application can easily use the values there to provide custom marketing campaigns or content delivery. Permissions can be designed so only school approved application can do so. Since the programs can just look up one value at a time like "FName", they don't need to spend time searching through and cropping the table from SQL. This makes it easier for smaller programs, like mobile apps, to use the data.

2. MBTI Decision Model

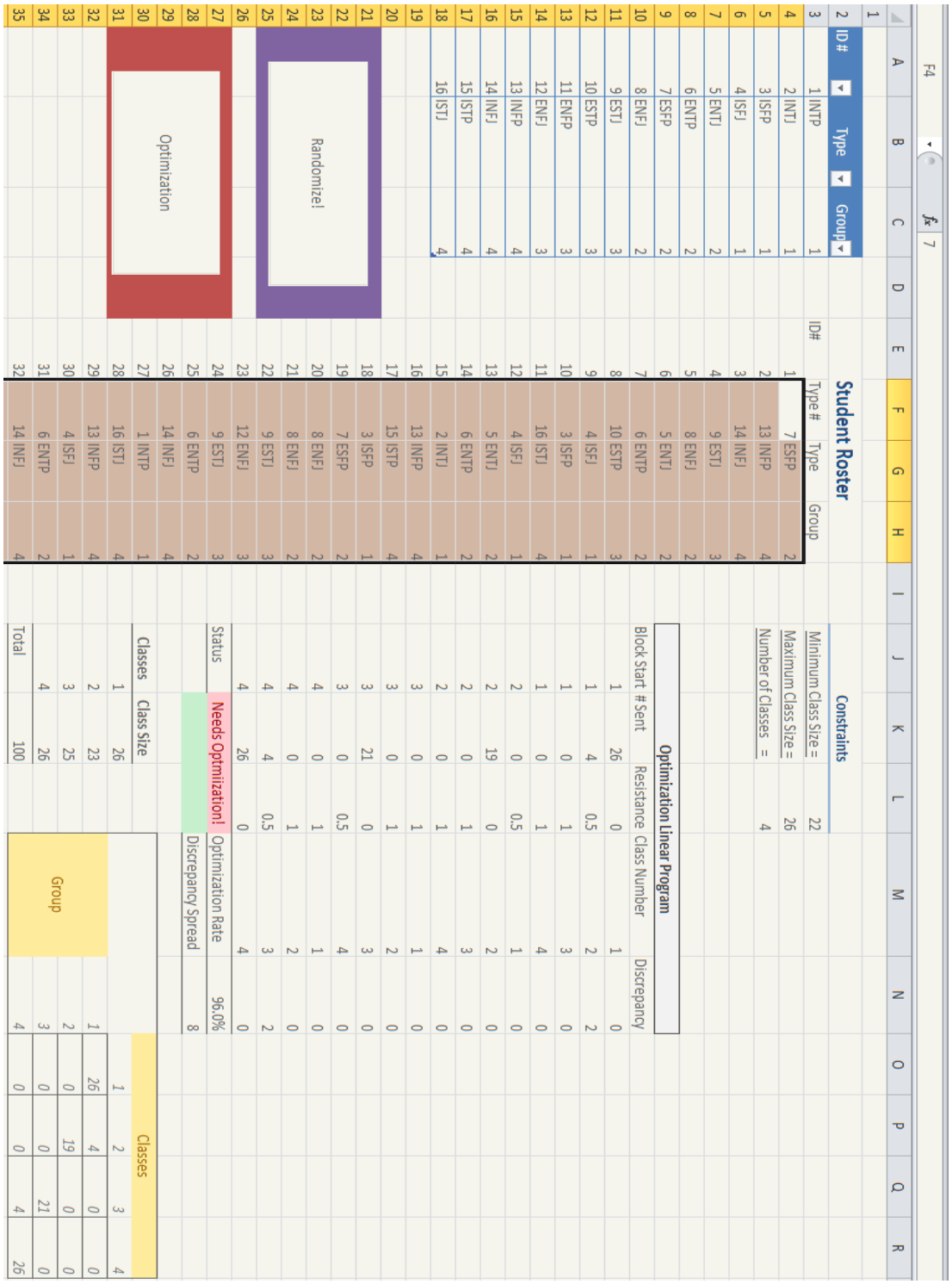


Figure 4.4 Decision model on startup

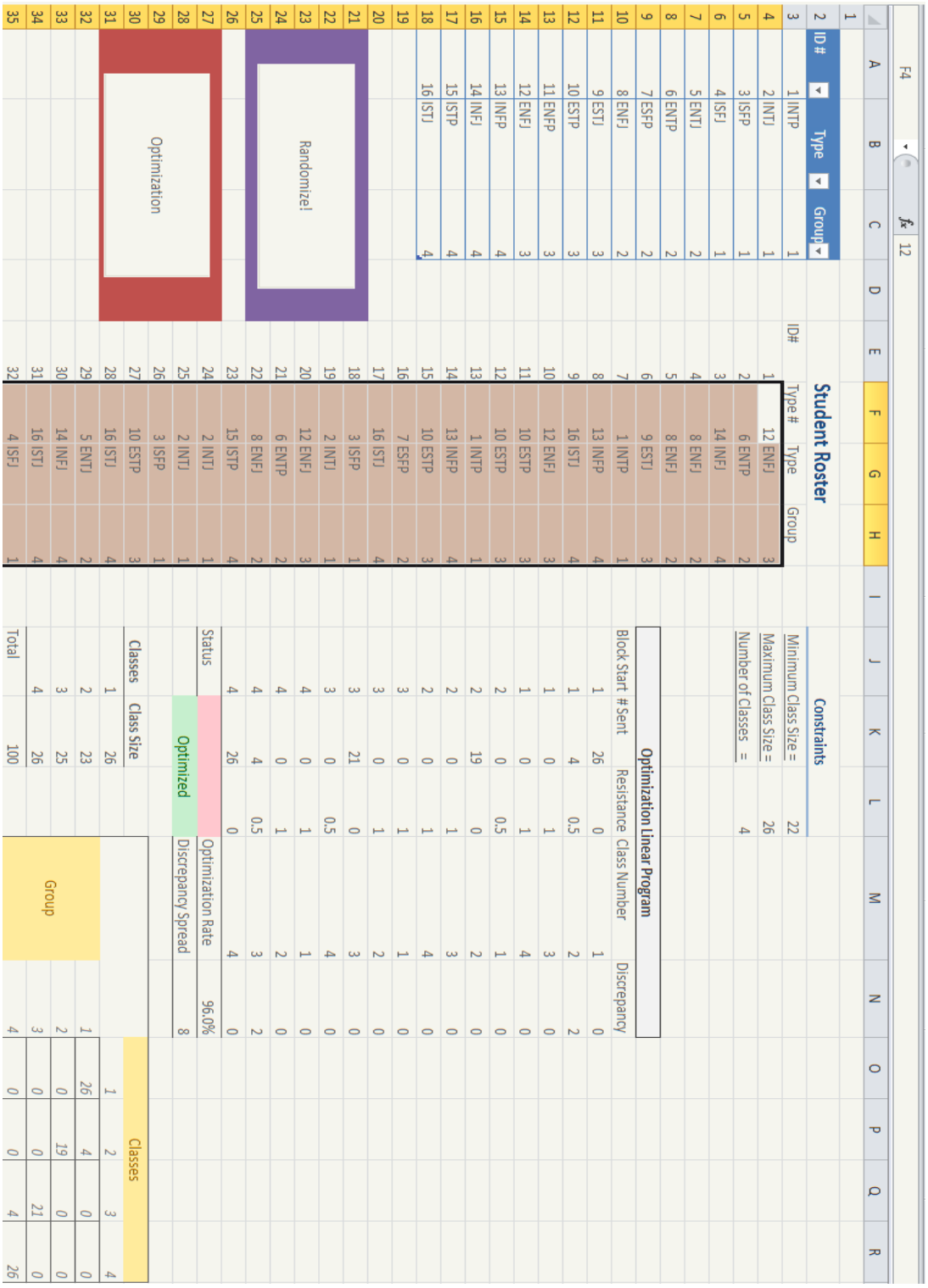


Figure 4.5 The randomize function has been executed. This populates the 100-student roster with random MBTI types.

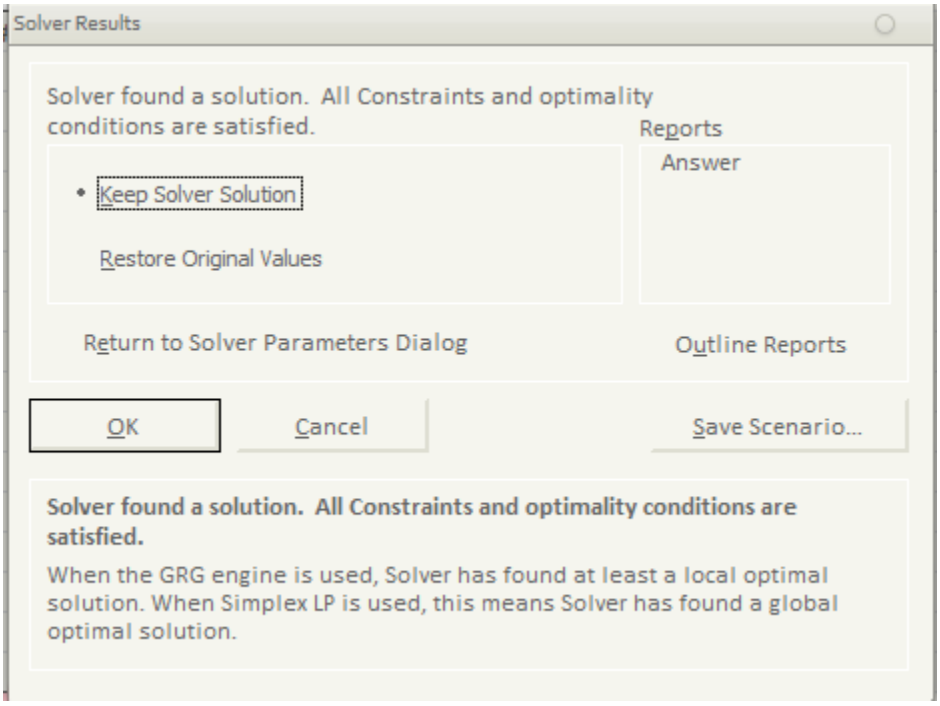
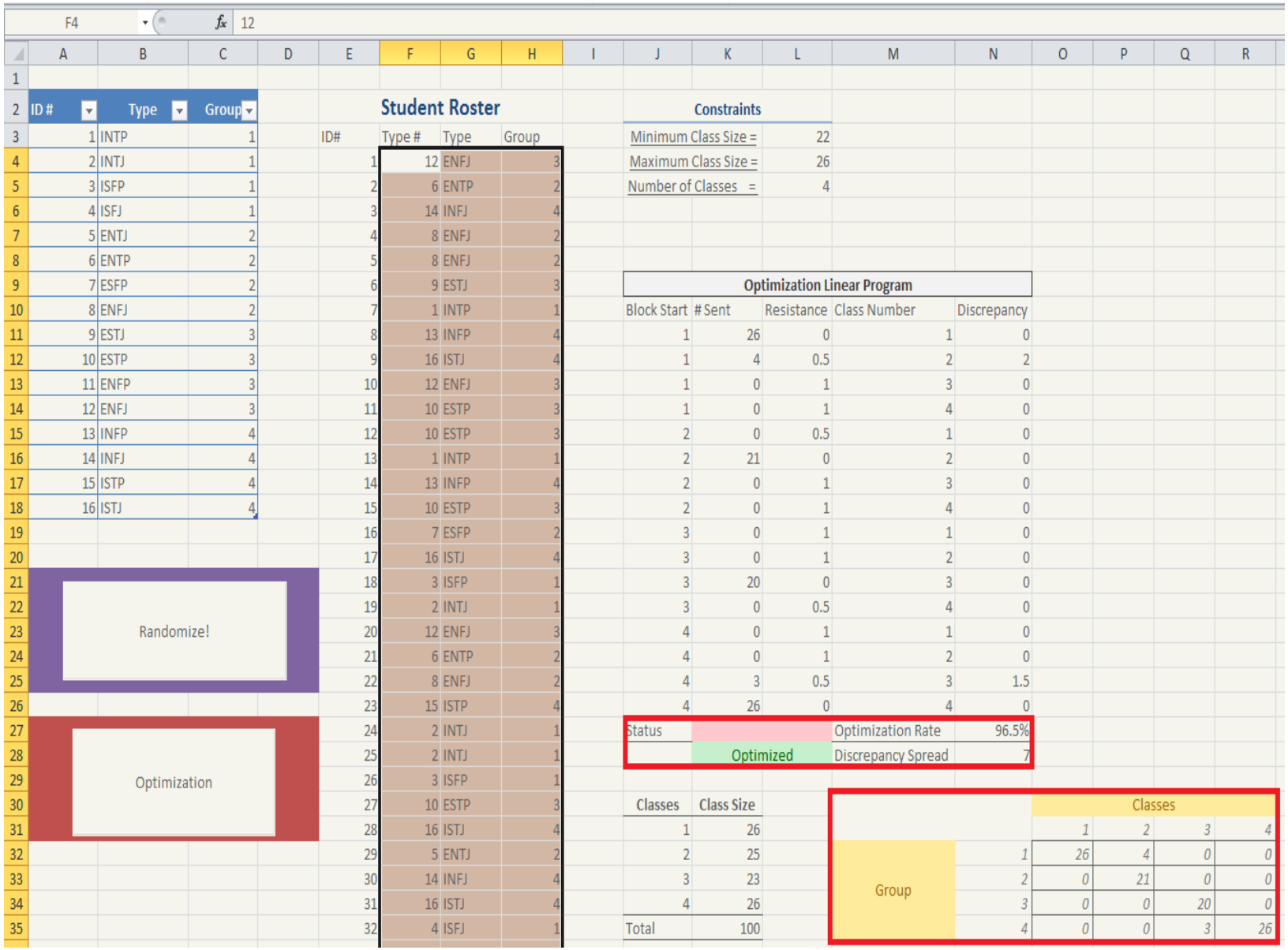


Figure 4.6 Execution of the linear program then finds an acceptable solution.



ID #	Type	Group
1	INTP	1
2	INTJ	1
3	ISFP	1
4	ISFJ	1
5	ENTJ	2
6	ENTP	2
7	ESFP	2
8	ENFJ	2
9	ESTJ	3
10	ESTP	3
11	ENFP	3
12	ENFJ	3
13	INFP	4
14	INFJ	4
15	ISTP	4
16	ISTJ	4

Student Roster

ID#	Type #	Type	Group
1	12	ENFJ	3
2	6	ENTP	2
3	14	INFJ	4
4	8	ENFJ	2
5	8	ENFJ	2
6	9	ESTJ	3
7	1	INTP	1
8	13	INFP	4
9	16	ISTJ	4
10	12	ENFJ	3
11	10	ESTP	3
12	10	ESTP	3
13	1	INTP	1
14	13	INFP	4
15	10	ESTP	3
16	7	ESFP	2
17	16	ISTJ	4
18	3	ISFP	1
19	2	INTJ	1
20	12	ENFJ	3
21	6	ENTP	2
22	8	ENFJ	2
23	15	ISTP	4
24	2	INTJ	1
25	2	INTJ	1
26	3	ISFP	1
27	10	ESTP	3
28	16	ISTJ	4
29	5	ENTJ	2
30	14	INFJ	4
31	16	ISTJ	4
32	4	ISFJ	1

Constraints

Minimum Class Size =	22
Maximum Class Size =	26
Number of Classes =	4

Optimization Linear Program

Block Start	# Sent	Resistance	Class Number	Discrepancy
1	26	0	1	0
1	4	0.5	2	2
1	0	1	3	0
1	0	1	4	0
2	0	0.5	1	0
2	21	0	2	0
2	0	1	3	0
2	0	1	4	0
3	0	1	1	0
3	0	1	2	0
3	20	0	3	0
3	0	0.5	4	0
4	0	1	1	0
4	0	1	2	0
4	3	0.5	3	1.5
4	26	0	4	0

Status		Optimization Rate	96.5%
	Optimized	Discrepancy Spread	7

Classes	Class Size
1	26
2	25
3	23
4	26
Total	100

		Classes			
		1	2	3	4
Group	1	26	4	0	0
	2	0	21	0	0
	3	0	0	20	0
	4	0	0	3	26

Figure 4.7 Post-optimization

Figure 4.7 shows the table optimized at a rate of 96.5% with a spread of 7. This means that the 3.5% variation from a perfect grouping is spread over 7 students. The table in the bottom left shows how many students from each group are sent to each class.

3. Programming Model – PsuedoCode

Figure 4.8 Psuedocode

```
Def Delivery:
        Var Mode =
        return(ID.LearningMode)
        Var Content [] =
                If:
                  selection = “”
                  return ID.Subject()<7
                else:
                  return selection
        For i ; i<content.length ; i++:
          Return Content[i].Mode
                If:
                        Close():
                        Break:
        End
```

Defines the delivery function

Sets the delivery mode to the students preferred method

If the student selected a review subject, returns that subject. If not, it gets a list of all subjects within the student’s file that are not complete.

Reviews the content according to the learning mode in order.

Ends the function

The code above is very simple, yet is able to function correctly because of the logical design on the databases. With its open ended structure, it is easy to add and customize the code to suit whatever needs you may wish to employ. These can include ways of tracking the student's zone of proximal development, providing a hint engine, or perhaps a points system for Gamification strategies.

APPENDICES

1. Interview with COO of Oldham County Schools, Rick Mchargue

In the Oldham school system, do any schools make use of student management systems that help to track student progress?

Schools in Oldham County (and all public schools throughout Kentucky) utilize Infinite Campus as the primary Student Management System to organize all student data including grades and assessment results. Additional , the state maintains a data base, the Continuous Instructional Improvement Technology System (CIITS), to organize each schools state assessment results. Edusoft is used by some of our schools to track and organize assessment results from various tests. Here's a link to the KDE website with a more in-depth explanation of the features available to teachers through CIITS: http://www.education.ky.gov/users/otl/CIITS/CIITS%20version%201.0%20Public%20Fact%20Sheet-FINAL.pdf

Are students given the ability to access any supplementary school materials at home, via the the web?

Several Oldham County Schools use Edmodo and Moodle to create on-line learning environments. Teachers post readings, videos, and assignments on

the sites; students access the resources placed on the site their by the teachers, post their assignments to the site, and engage in discussion groups with their peers regarding the lessons.

Right now, are there any substantial efforts to individualize the education for students on a learning mode basis?

I'm unaware of any schools that are systemically using technology for tailoring instruction based on learning modalities.

Are there any reward systems for assignments and student progress to encourage participation and a personal interest in the content?

I also am unfamiliar with any efforts in the district to use a reward system for participation or assignment completion.

If you were to consider further integrating new technologies and the standard public K-12 classroom, what do you foresee would be the biggest barriers?

I'm working to alleviate the three major barriers to the integration of technology is K-12 education: Vision (a clear understanding on the part of teachers of how technology can be used to effectively engage students at deep levels of learning) 2. Access to Resources(both to hardware, software, and internet service) 3. Professional Development.

As a method of addressing these three barriers, we've developed a teacher-initiated, teacher-lead learning community we call OCTI (Oldham County Technology Initiative). Teacher who share a common interest in furthering the implementation of technology in their instruction come together in both an on-line and face-to-face learning to share ideas and strategies to use technology as a tool to increase relevancy and engagement. The group has a Moodle page where lessons, ideas, reflections and app reviews are shared, a Microsoft LIVE listservr to share thoughts, stories, and tip; a monthly e-newsletter is generated highlighting ed-tech ideas, and an intensive two-day conference for PD and in-school observations of model classrooms.

2. 9th Grade Behavioral Information AccessSQL Code

```
SELECT Students.ID, Students.Grade, Students.[First Name],
Students.[Last Name], Students.[Social Type], Students.[Learning
Modality]

FROM Students

WHERE (((Students.Grade)="9"));
```

3. Mongo DB Trigonometry Progress Code

```
Example Subject Area Tracker - Bloom's Taxnomy Progress:

var Trigonometry = {
Radians_to_Degrees: 7,
Degrees_to_Radians: 7,
Radians_Degrees: 7,
Unit_circle: 7,
Trig05: 6,
Trig1:5,
Trig105: 5
Recip_Trip_func: 6,
Trig2: 4
Special_RT: 4,
Pythag_Ident:4,
Add_Sub_Ident:3,
Inverse-Func: 2,
Sin_Cos_Graphs: 1,
Law_Cos: 0
}


Updating Progress:

db.studentID.update(
    {_id: Trigonometry},
    {
        $set: { Trig05: 7 },
    }
)
```

Figure 4.9 noSQL Update Function

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