Computing A2 Physics Educational Aid

Contents

1. Introduction

1.1. Client Introduction

My client Niamh McNabb is a degree level physicist that has been teaching for many years and is also assistant head of studies at Long Road Sixth Form College. She has been teaching Physics for over 10 years and has great interest in physics and regularly attends physics conventions at Cambridge and Oxford. She has a great interest in traditional physics such as mechanics and

1.2. Define the Current System

The current system is taught manually by teachers via a PowerPoint presentation or for users who are not in education by searching the internet for information. It requires people to make notes by hand when viewing a PowerPoint presentation taking up their concentration during lessons that could be used to listen to other advice given by the teacher that may not be included in the PowerPoint presentation. Repetitive questions involving equations are one of the best teaching methods used in physics, and are one of the most effective methods of learning. Text books are also used to help learning and can be effective when learning the theoretical process involved in the equations. There is also PhET a university run website that hosts various simulations of Phenomena in physics. The system has many forms of mechanics in physics, e.g. moments, torques and projectiles. PhET simulations are also very accurate being created by undergraduates, degree level physicists and professors alike.

1.3. Describe the problem

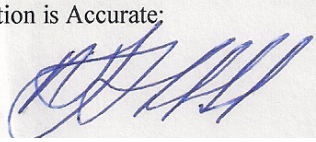
- PhET simulations have no questions and so cannot be completed as a lesson objective without other resources.
    - PhET simulations are good however they have no questions and can only be used to demonstrate the effects of phenomena in physics by adding elements the simulations of projectiles could become an activity users could completed on their own during lessons.
- Distractions from the simulation are possible because they do not pose questions to the user.
    - The Current system is not interactive so it is possible for the user to become disinterested in the topic. By making an interactive program the user will have to answer questions and can interact with the motion of projectiles.
- Students struggle to understand the speed of an object just from a written value.
    - Students especially struggle to get students to relate to projectiles on paper because of their difficulty in visualising the scale and speed of projectiles from a written value, visualisation in physics is one of the most important things as trying to imagine large objects can be very difficult. E.g. an asteroid: $1x10^{15}m^3$.

1.4. Section Appendix

Questionnaire

1. A brief description of your job title some brief personal details if you want? Physics teacher and Assistant Head of Studies
3. A career description, what you do etc.?Teach physics and provide guidance
5. An explanation of any computer based systems you currently use to teach students. PowerPoint and PhET simulations
6. Any problems regarding projectiles and the environment you have when teaching that could be solved using a computer. Demonstrations of projectile motion. Ensuring students understate that horizontal and vertical motion is independent of horizontal velocity is zero.
6. Any specific objectives you require of the system I will write. Students can use it to design and analyse scenarios.
7. Your skill or knowledge regarding computers? Very good working knowledge
8. Phenomena in Physics when throwing projectiles I should include? Consider two scenarios: object fired up and object fired horizontally (eg off a cliff). Any examples that you think students would find interesting should be included.
9. Phenomena in Physics when throwing projectiles I should not include? No.
9. Or any alternative suggestions I should include? You could extend it to look at gravitational fields (an A2 topic) and so look the motion of planets and stars (NOT projectile motion).

I The Client Confirm that this information is Accurate: Date:



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2. Investigation

2.1. The Current System

2.1.1. Data Sources and destinations

All data sources contain verbal communication however this depends on if the student is in lesson or instead studying at home.

Data Source	Travels via	Destination
Teacher	Written or verbal communication	Student
PowerPoint Presentation	Written, Verbal or Visual communication	Student
Books	Written or Visual Communication	Student
Internet	Written, Visual or Verbal communication	Student
Videos	Written, Visual or Verbal communication	Student
Questions by student	Verbal, written communication	Teacher
Demonstrations	Written, Visual, Verbal or Kinaesthetic communication	Student

2.1.2. Algorithms

There are a few algorithms in use; the first here is if a student does not understand a topic in a lesson.

IF (Student =Does Not Understand)THEN

Explain Individually

ELSE

Go to Next Student

END IF

This Algorithm is for returning homework, based on the students score after marking.

IF (Homework= Below Acceptable Grade)THEN

Return to Student

ELSE

Approve

END IF

This Algorithm is used to review a students' progress over the half-term.

IF (Review Sheet = Unfinished)THEN

Assume Student Does Not Understand

ELSE

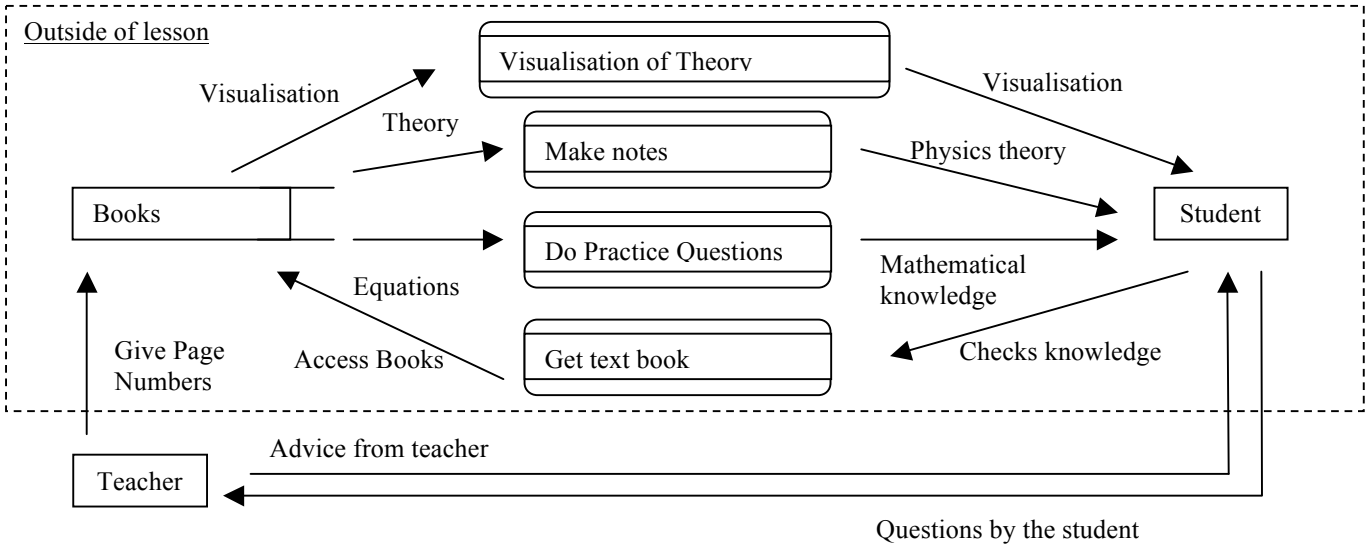
Student Must Understand

END IF

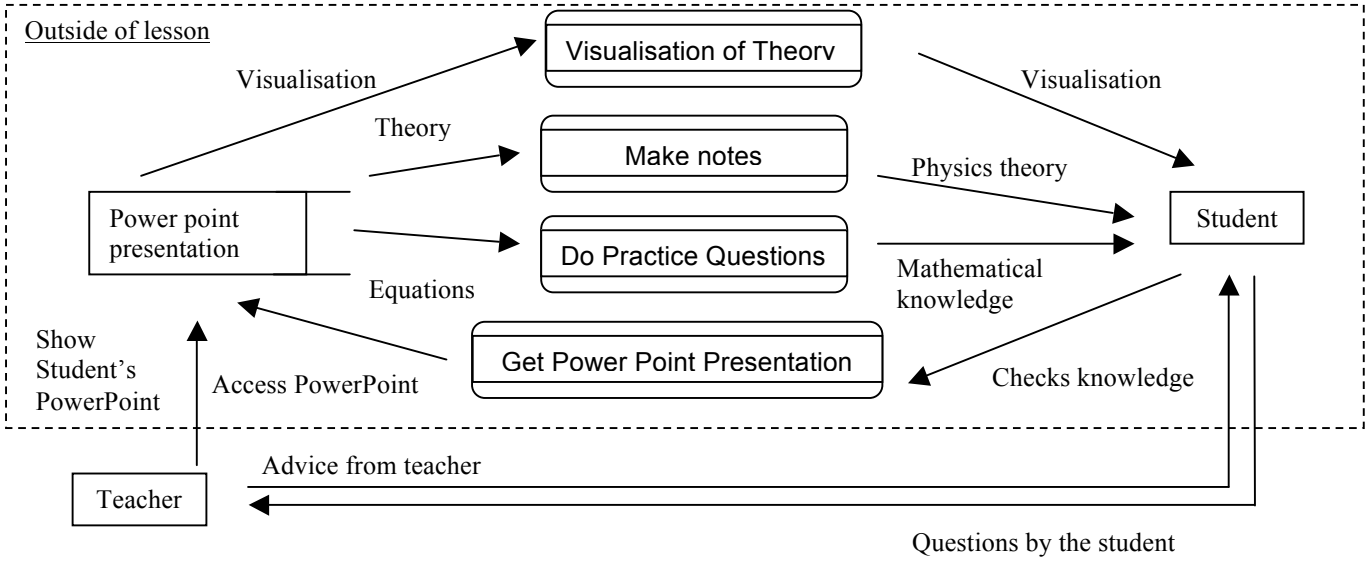
2.1.3. Data flow diagram

Symbols Key:

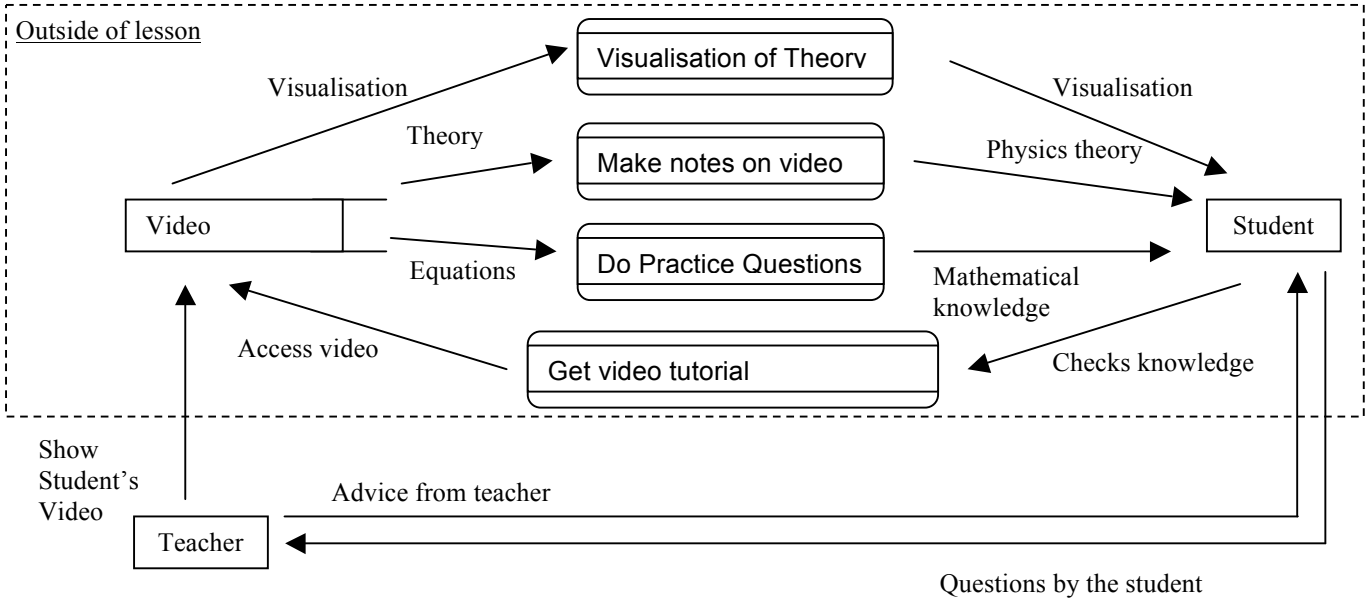
Books: This algorithm shows the process a student takes to learn from a textbook, the text book is the primary data store for the student it is published from the exam board and contains all the information the student will need to complete the course. It also contains questions and images which can give the user limited visualisation of physics theory.



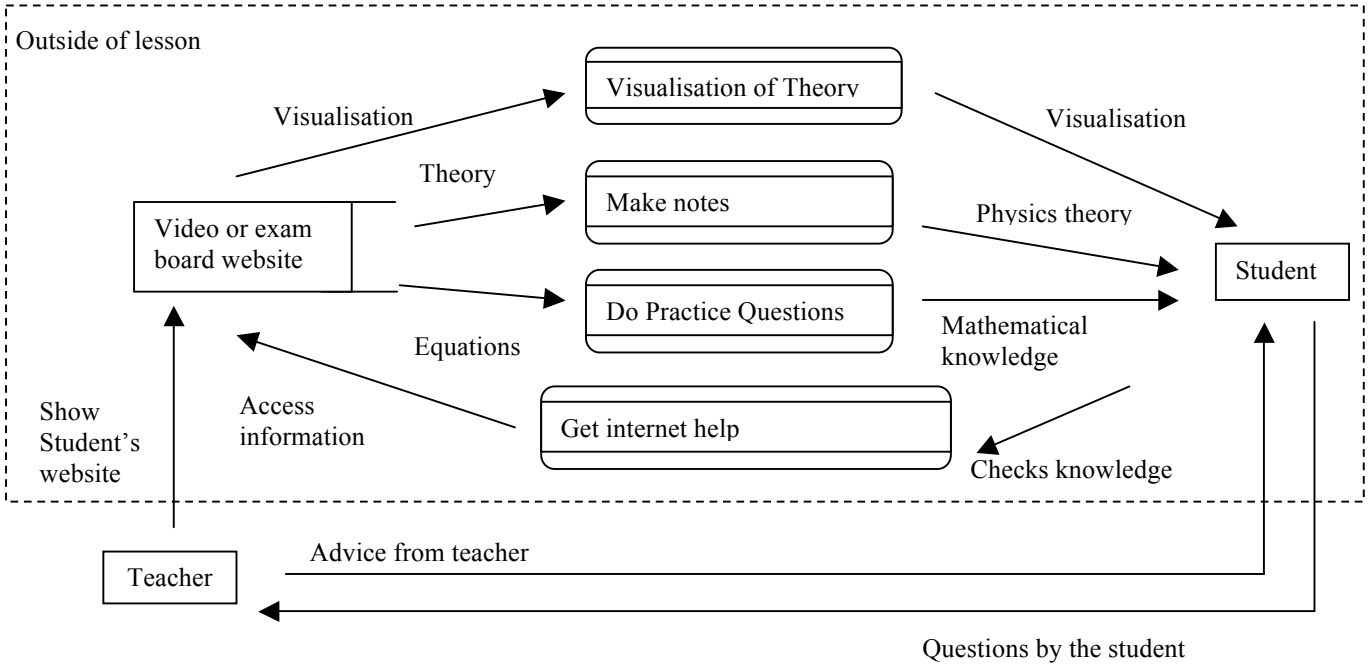
Power Point Presentation: This algorithm shows the process a student takes to learn from a PowerPoint. A PowerPoint can be a very powerful educational tool because of its value in revision, and is also very strong at creating group discussion during lessons. It can also show images which can give the users some limited visualisation of physics theory.



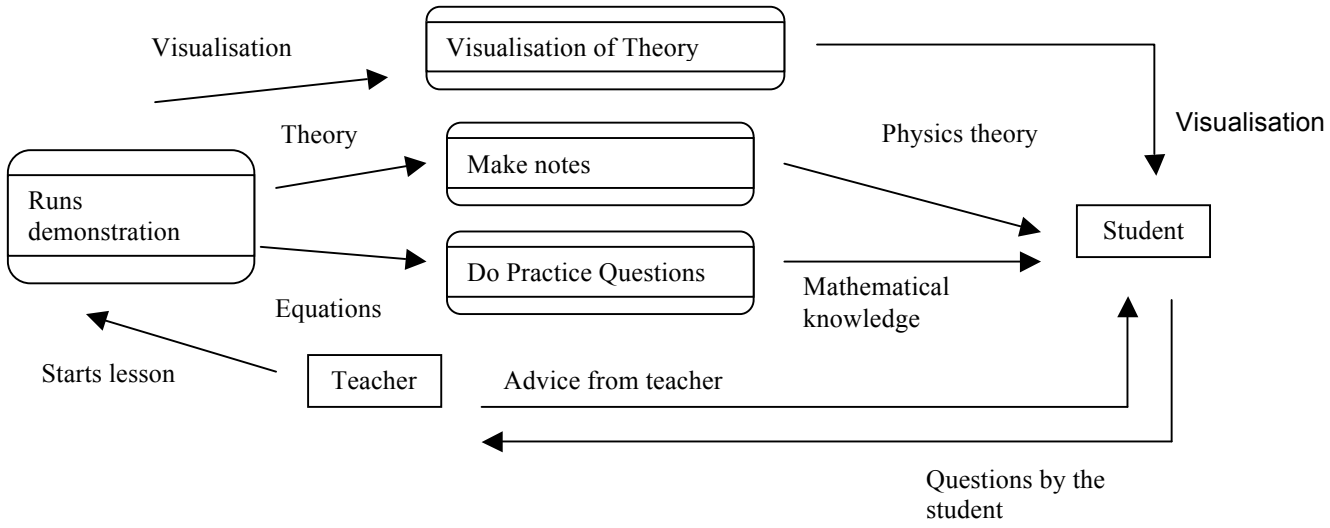
Video: Videos can also give helpful information about physics theory, they can contain questions at which point the student must pause the video, to make full effect of the learning material the student must pause the video and must also make notes on the material covered within the video.



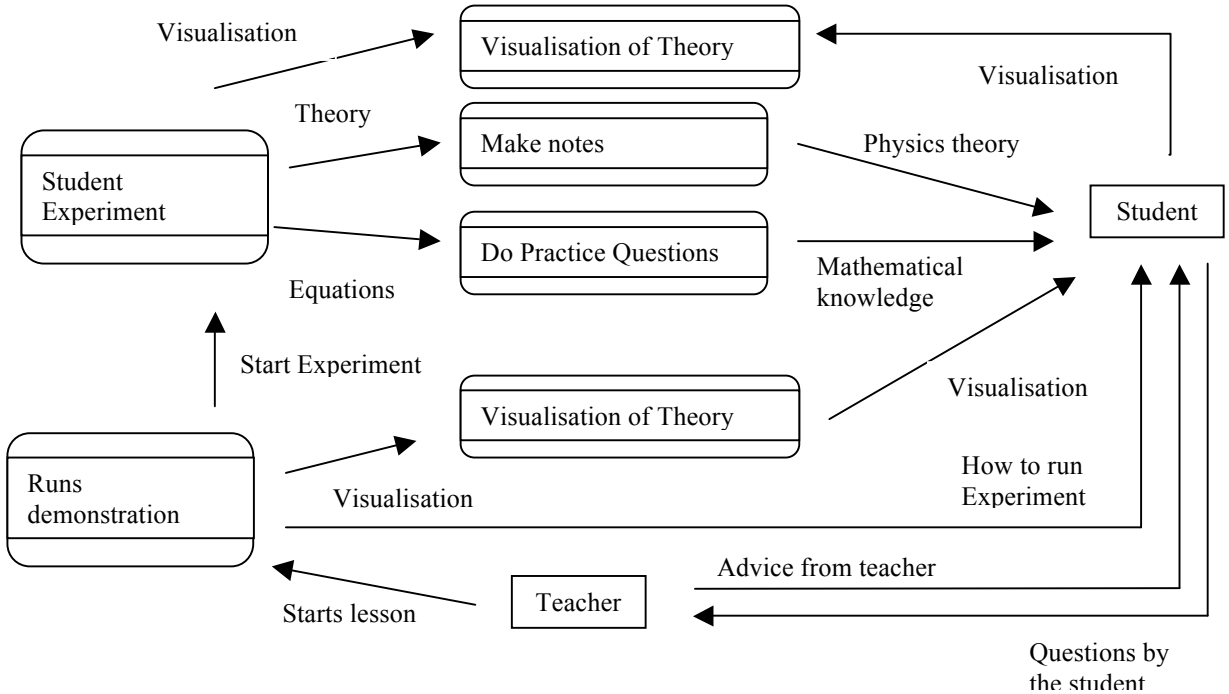
Internet: The internet can be a valuable source of information when textbooks are not available or do not contain the information students require, it's also faster to search the internet instead of a textbook.



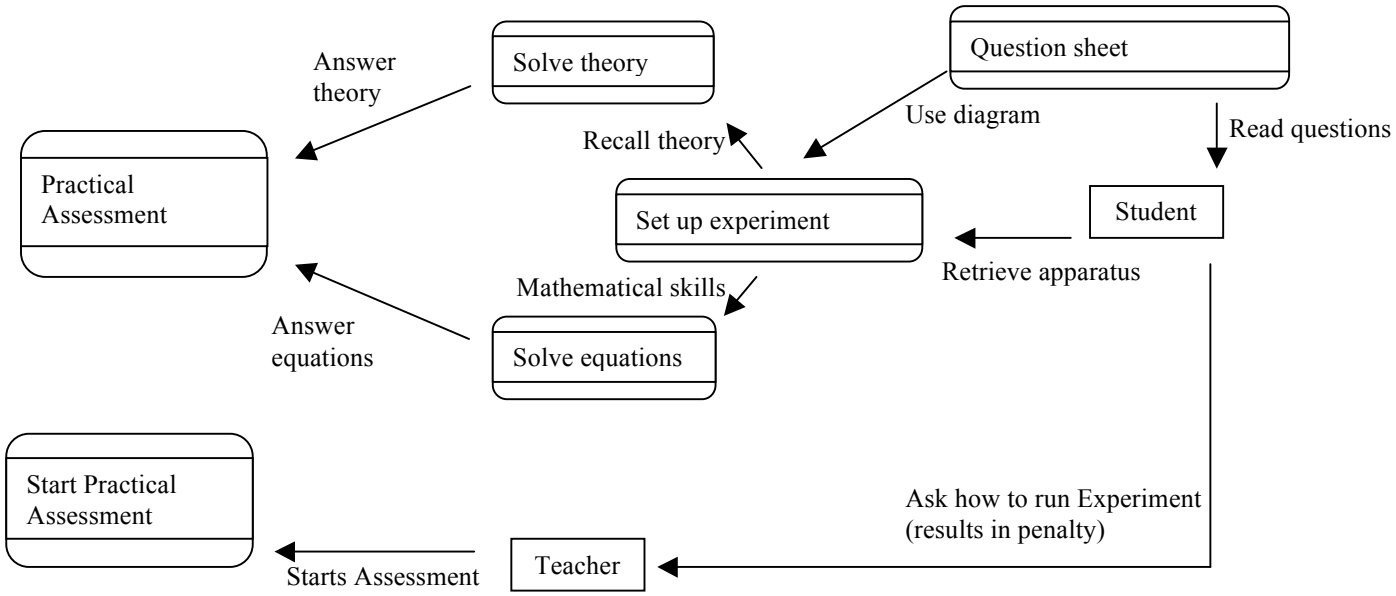
Demonstration: This algorithm shows the process that a student takes to learn from a demonstration, these are not experiments and the reason for this is, is that they are deemed unsafe for students to perform. Because Demonstrations are run by the teacher they cannot be replicated at home.



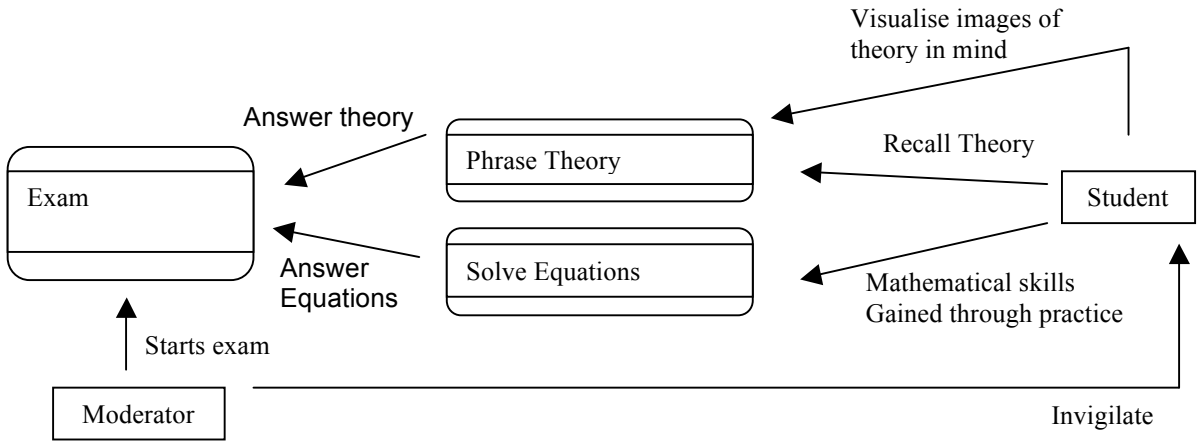
Experiment: This algorithm shows the process that a student takes to learn from an experiment, similar to a demonstration however students will perform the experiment after being shown a demonstration by the teacher. Because experiments involve equipment they cannot be completed at home by the student.

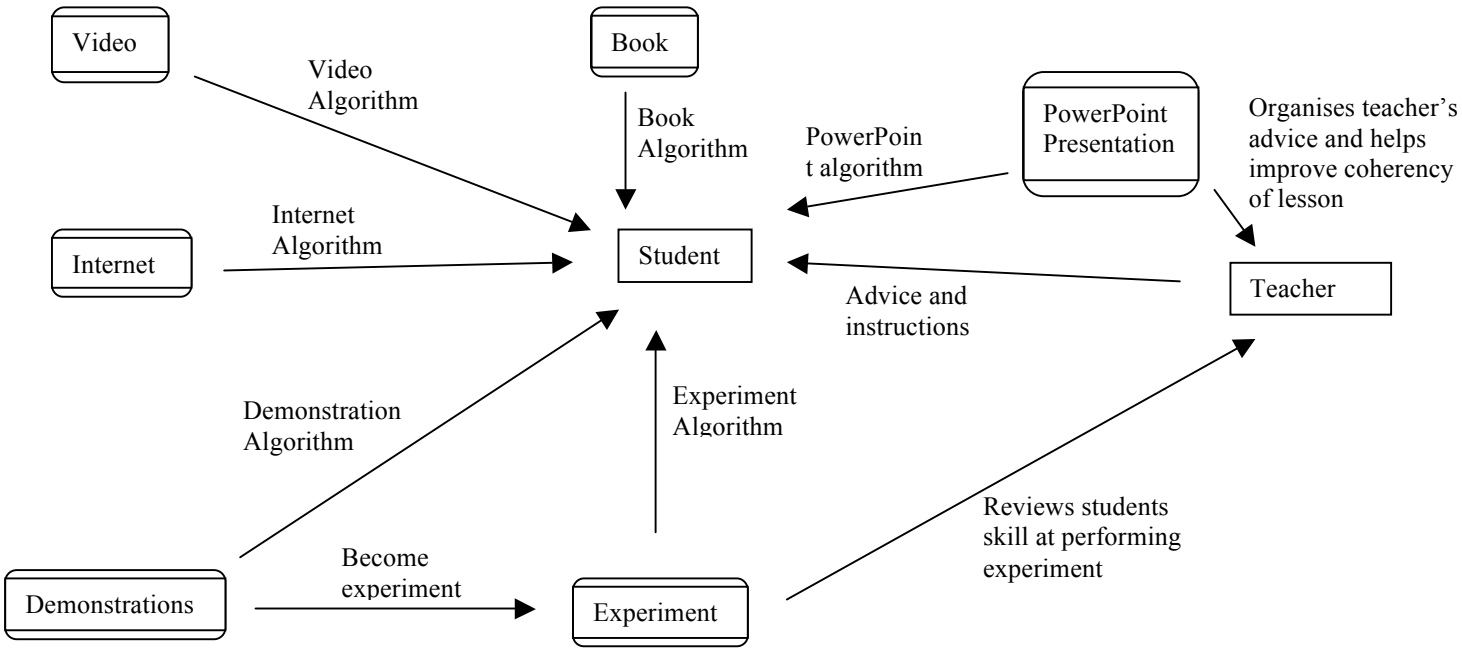


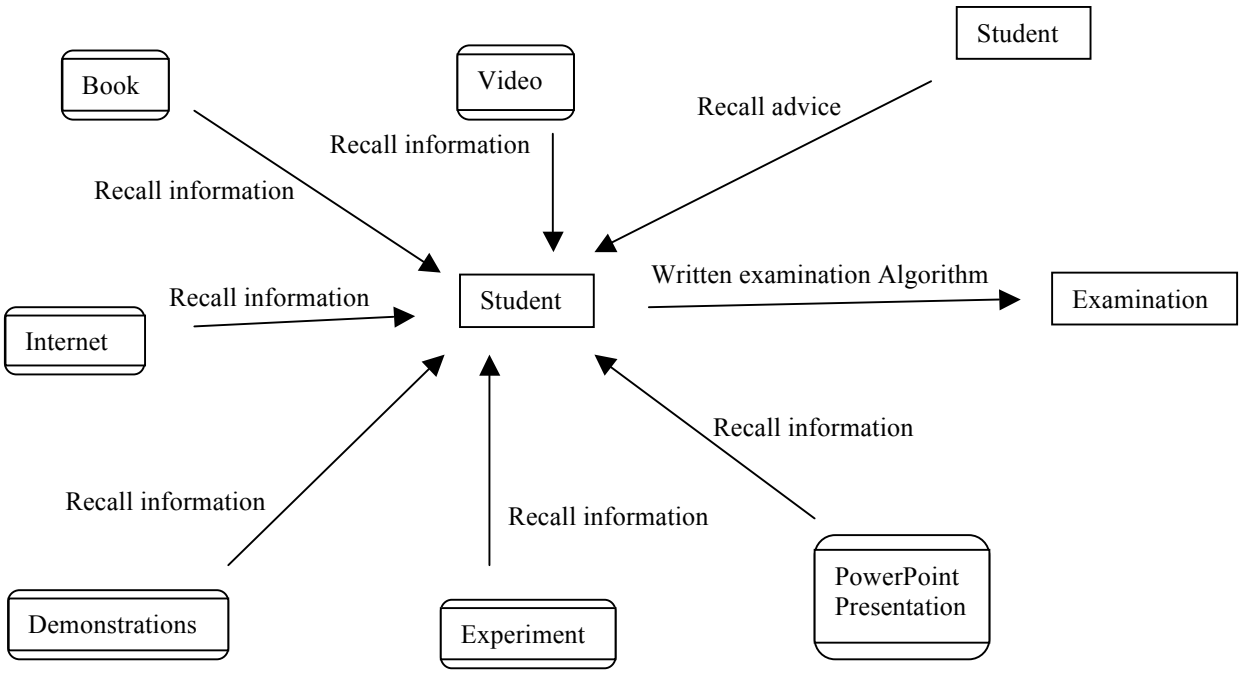
Practical Assessment: Practical assessment in physics is the recreation of an experiment and the explanation of the physics behind the phenomena through use of structured English and equations.



Exam Assessment: An assessment in physics can be in two ways an exam moderated by the exam board. Or it can be an experiment under scrutiny of the teacher. The majority of the student's results will depend on these written assessments.




Video
Book
Video Algorithm
Book Algorithm
PowerPoint Presentation
PowerPoin t algorithm
Organises teacher's advice and helps improve coherency of lesson
Internet
Internet Algorithm
Student
Teacher
Advice and instructions
Demonstration Algorithm
Experiment Algorithm
Reviews students skill at performing experiment
Demonstrations
Become experiment
Experiment


Student
Book
Video
Recall advice
Recall information
Recall information
Written examination Algorithm
Recall information
Student
Examination
Internet
Recall information
Recall information
Recall information
PowerPoint Presentation
Demonstrations
Experiment

2.1.4. Input Forms, Output Forms, Report Formats

Feedback to the teachers is a sheet that has a checklist of all the topics studied during the term. This sheet is distributed to students during the term and is due the start of the new term students must demonstrate that they can recall all the knowledge from the term on their own without help from the teacher. If they cannot than data sources such as text books must be referred to complete the task, effectively forcing the student to revise the topic. Information to the teacher is also input as homework and provides the teacher with information with which a teacher can make a decision about a students' progress.

Output to the student is largely given to the student as advice during lessons. It is also given as corrections on homework and practice examination papers.

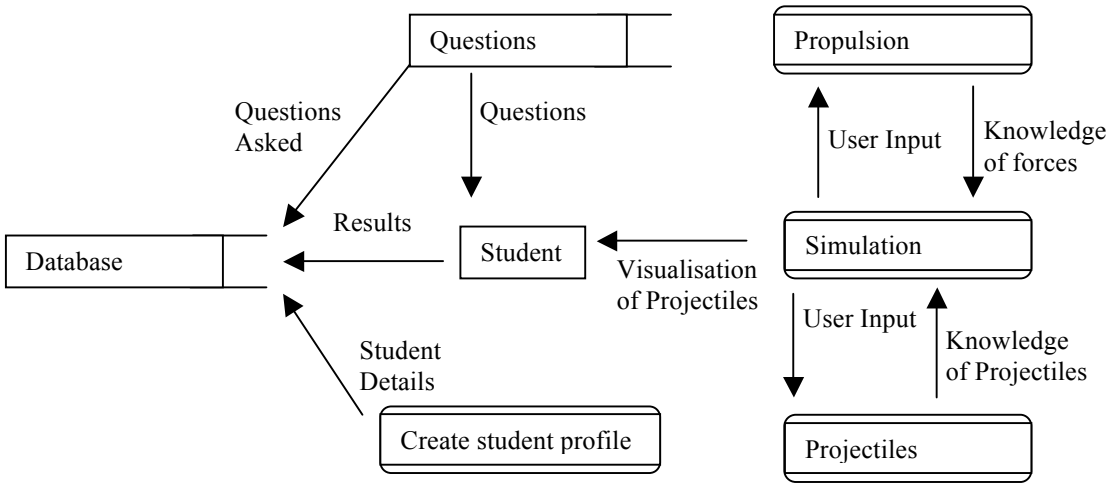
Reports are given to students in homework as a low score indicates that a student is struggling with a topic and action can be taken by teachers with regard to homework by using this as an indication of the student's progress.

2.2. The Proposed System

2.2.1. Data Sources and destinations

Data Source	Travels via	Destination
Results of questions	Written or verbal communication	Student and teacher
Projectile information window	Written or Visual communication	Student
Active forces information window	Written or Visual Communication	Student
Force of gravity	Visual communication	Student
Trajectory of projectile	Visual communication	Student
Mass of projectile	Visual communication	Student

2.2.2. Data Flow Diagram



2.2.3. Data Dictionary

Data	Uses	Name
TestQuestion1	Test user's knowledge of projectiles. By use of an examination and a score card at the end of the program	test_Question1
TestQuestion2		test_Question2
TestQuestion3		test_Question3
TestQuestion4		test_Question4
TestQuestion5		test_Question5
TestQuestion6		test_Question6
TestQuestion7		test_Question7
TestQuestion8		test_Question8
TestQuestion9		test_Question9
TestQuestion10		test_Question10
TestQuestion11		test_Question11
TestQuestion12		test_Question12
TestQuestion13		test_Question13
TestQuestion14		test_Question14
TestQuestion15		test_Question15
Object ID	Unique identifier of an object	projectile_ID
Object Name	The objects name	projectile_Name
Location Name	The location of the simulations name	Location_Name
Height at Location	The height of the simulation in the location	Location_Height
Force of gravity	How powerful the gravity is at the location of the simulation	gravityat_Location
Diameter of Object	The Objects Diameter	projectile _Diameter
Mass of object	Object Weight	projectile _Weight
displacement	How fast an object has to travel	projectile _Distance
Time spent travelling	How long an object has currently travelled	projectile _flightTime
Student ID	Used in case students have identical names	student_ID
Student Name	Students name entered at beginning of program	student_ Name
Date of use by student	Shows on which day a student completed the program	student_dateOfUse
Student results	Shows the results of questions.	student_Results
How long a student spent during their session	Shows how long the student spent in their session	student_sessionTime
Displacement	Total distance	Displacement
Total time to travel	Total time to destination	Time
Initial Velocity	Velocity when time = 0	initial_Velocity
Final Velocity	Velocity when student pauses the simulation	final_Velocity
Horizontal Force	Force of the projectile along the horizontal axis	horizontal_Velocity
Vertical Force	Force of the projectile in along the vertical axis	vertical_Velocity
Angle	The Angle at which the projectile travels	Angle

2.2.4. Volumetric

Students

I should be expecting a total amount of data transfer of 34 Bytes + however many times the SUVAT Equations are run a second to create a realistic simulation. So the amount of data stored will be quite small however the amount of data produced per second will be very large. And so the program will be more CPU intensive than storage intensive as the excess data from the simulation can be discarded.

Student Database

The Data Base will store 36 KB of information however there could be as many as 100 students so there

3. Objectives

3.1. General Objectives

- Core objective 1: Educate the user about the movement of projectiles.
- Core objective 2: Ensuring students understand that horizontal and vertical motions are independent and horizontal velocity is zero.

3.2. Specific Objectives

- Ensure that the program can calculate all SUVAT equations correctly
- Ensure that the program can display different projectile types.
- Ensure that the program can simulate the trajectories of the projectiles in different locations
- Ensure that the program can calculate the Horizontal Force
- Ensure that the program can calculate the Vertical Force
- Ensure that the program proves the independence of Vertical and Horizontal forces and Horizontal Velocity is zero.
- Ensure that the program displays the active forces and the direction of travel accurately
- Ensure that the program can run well on a laptop
- Ensure that the program asks appropriate questions within the user's ability
- Ensure that the programs code correctly disposes of excess data

3.3. Core Objectives

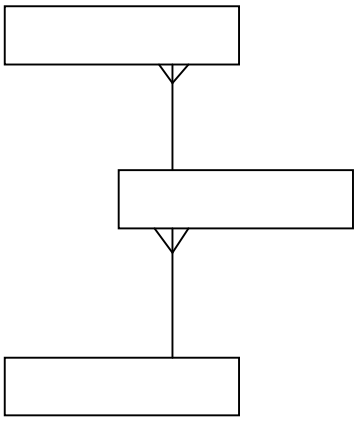
- Must be able to display a student's results
- Must be able to have multiple students
- Must be able to simulate projectile Motion Accurately.
- Must be reasonable challenging

3.4. Other Objectives

- Ensure the program restricts a user's access.
- The user should be able to backup the data

4. E-R

4.1. E-R Diagram



abel

ttribute

ehaviours

m

Projectile

Object ID
Object Name
Mass
Diameter

EditMass
EditDiameter
EditName
CreateObject ID

Simulation

Propulsion

Horizontal Force
Vertical Force
Initial Velocity
Final Velocity
Acceleration

EditMass
EditDiameter
EditForce
EditAngle
EditAcceleration

Simulation

Propulsion
Horizontal Force
Vertical Force
Initial Velocity
Final Velocity
Projectile
Acceleration
Object ID
Object Name
Mass
Diameter
Displacement
Time
Gravity at location
Height at location

EditMass
EditDiameter
EditForce
EditAngle
EditAcceleration
EditMass
EditDiameter
EditName
CreateObject ID
EditGravity
EditHeight

4.2. Entity Descriptions

Entities

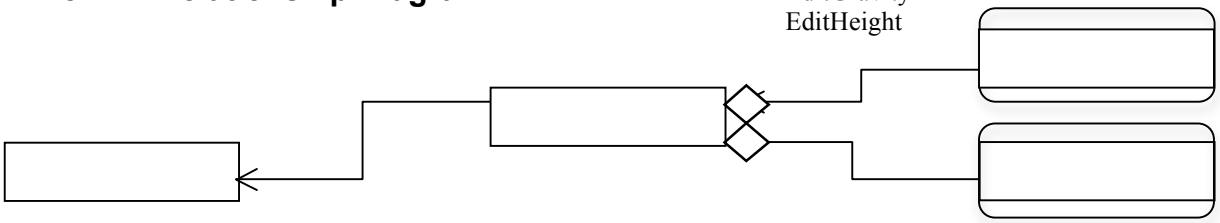
Student(StudentID, QuestionsID, timeInSession, DateofUse)
Database (DatabaseNo, *StudentID*)
Questions(QuestionsID, QuestionsList, Question1 result, Question2 result, Question3 result, Question4 result, Question5 result, Question6 result, Question7 result, Question8 result, Question9 result,Question10 result)

5. Object Analysis

5.1. Object Listing

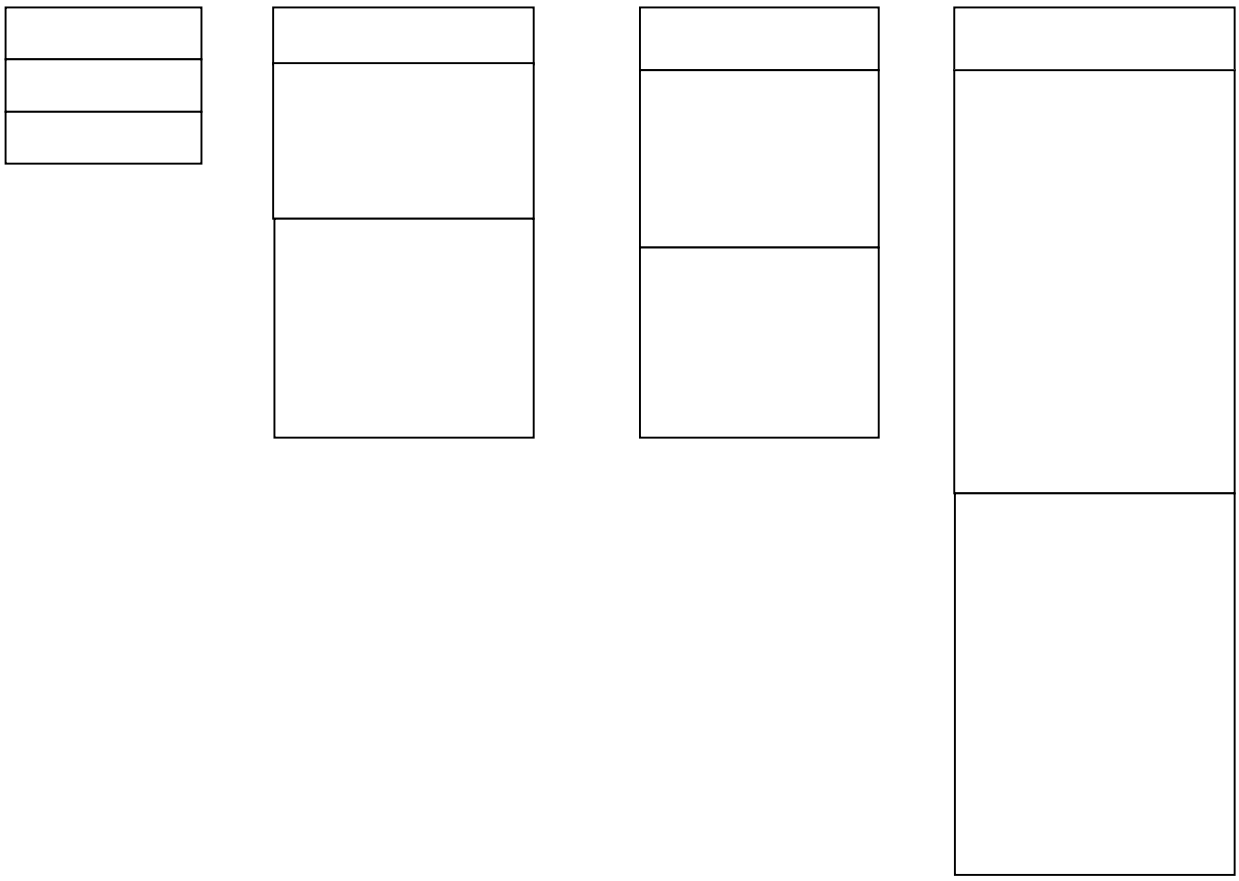
Projectiles - Holds information specific to the object in the simulation e.g. Mass
Propulsion – Holds information specific to the force at which the object will be travelling at.
Simulation – Combines Projectiles and propulsion to form the simulation.

5.2. Relationship Diagram



5.3. Class Definitions

Keys:



6. Other Abstractions

6.1. Graphs

Not Yet

7. Constraints

7.1. Hardware

Hardware:

Make: Viglen
Model: Futura Durus S15S
CPU: Intel Core 2 Duo T8100, 2.1GHz
RAM: 4GB
HDD: 160GB
Screen resolution: 1280x800

These computers are old and are designed to last the maximum amount of time possible running basic programs. The screen resolution is also quite small so the GUI should not require a large screen resolution to be displayed. The Laptop also has no Number pad so the program should not be designed around the number pad. The hard drive space is low however due to the small amount of hard drive space required by the program it will likely be negligible.

7.2. Software

I will write the program in python with the PyQt extension, with this I can make accurate models of projectile motion. The Operating system is windows XP a reliable Operating system that rarely has compatibility issues. So I do not think that I will have issues bringing the program onto this operating system.

7.3. Time

I have less than six months to complete the program, should meet all my general objectives. The client will not need the program before this date.

7.4. User Knowledge

The user has a basic knowledge of computer systems; the program should have a good GUI enabling all users to understand how to use the program. The user mostly uses the computer to submit reports and to browse the internet.

7.5. Access Restrictions

There will be an access restriction to edit information within the database. However all users will be able to view the information within the database. There will be few other barriers within the simulation except the questions and where the user could cause an error with in-appropriate values.

8. Limitations

8.1. Areas which will not be included in computerisation

The movement of the air as this is information that students will not need for the syllabus. And it would be difficult to automate.

8.2. Areas considered for future computerisation

Random questions, the mathematical questions could be randomised. To provide so reusability for the program.

9. Solutions

9.1. Alternative solutions

- A web based solution would be the best solution as it could link all the databases together giving the teacher a view of all the students' results, in a concise spreadsheet showing the teacher which students understood that horizontal and vertical motions are independent. However I cannot code in a web based solution.

- I could code the program in python using PyQt, and is a programming language I am quite familiar with however the teacher would have to inspect the results of each student independently.

- The program could be completed by creating a simulation that takes no results from the questions it poses. Forcing the students mark the questions with the class, instead of being marked by the program. This would create larger class interactivity as the students discuss their findings with their teachers

- I could improve the manual system by creating a worksheet that contains all the questions and pre-created values for projectiles and propulsions. This would create an activity that small groups could complete rather than the whole class keeping more students engaged in the activity

- By creating a database using SQL. Without the simulation I could easily show the teacher the results of questions, and group the entire class together in a database.

9.2. Justification of chosen solution

I have chosen the Python and PyQt GUI solution because I know how to code in this programming language. I did not choose the web based solution as I do not know how to program in a web based code. And any programs I did write would be incredibly basic and would not be as polished as the PyQt option. I instead choose to create the questions to force the user to create some serious simulations and utilise the program in a meaningful way instead of creating ridiculous trajectories and projectiles. I choose not to choose the improved manual solution because putting students together in groups can often lead to distractions and loss of focus during lessons. The database solution did not simulate the projectiles and did not prove to students that vertical and horizontal motions are independent and horizontal velocity is zero.