

ENGINEERING OUTREACH BY ASKING “WHO WANTS TO BE AN ENGINEER?”

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Abstract

A popular television show inspired the development of a game intended for use with engineering outreach activities, such as open houses and classroom presentations, at the University of Kentucky’s Paducah extension campus. Available freely for download, the game inspires students to consider engineering as a potential profession by demonstrating that students already know some things that an engineer will need to know. The game itself, called “Who Wants to be an Engineer?”, is an individual quiz consisting of three grade-level specific questions of increasing difficulty covering topics in basic mathematics, science, and engineering. Correct answers result in the student winning prizes donated by local industry. Four people, a computer, and large format computer display (e.g. LCD Projector) are required to run the game in its typical showcase implementation. Both participants and the audience indicate the game is entertaining. Assessment conducted to date indicates students do exit the game with a more positive impression of engineering and an increased willingness to consider engineering as a career option.

Introduction

Engineering faculty members frequently have the opportunity to introduce engineering to students of all ages. This holds true for faculty members employed by new programs, such as the mechanical and chemical engineering programs at the University of Kentucky (UK), College of Engineering Extended Campus Programs in Paducah, Kentucky.[1,2] In the Fall of 2000, faculty, staff, and students began planning for its first Open House, to be held in conjunction with National Engineer’s week. Since this was a new

program, there was no history of activities previously conducted to draw from, so planners developed a slate of activities based on what was done on the main UK campus in Lexington, Kentucky.

In addition to those activities, the chemical engineering students in the UK Paducah chapter of the American Institute of Chemical Engineers (AIChE) developed a game based on what was at the time the most highly rated program on American television, “Who Wants to be a Millionaire?” On this show, contestants have the opportunity to win cash prizes by answering multiple choice questions of increasing difficulty. As the question difficulty increases, the prize value increases until it reaches one million dollars. If a question is answered incorrectly, prize money is lost. A player can quit the game at any time with no penalty. Also, contestants have the opportunity to receive limited help from the audience in the form of a poll, from a friend via a telephone call, and from having two incorrect options removed from the four choices presented to them.[3]

Students, in conjunction with the chapter’s faculty advisor, developed sets of questions for a quiz game using sets of PowerPoint slides. The rules were similar to that of the game show. While the game, “Who Wants to be an Engineer?”,[4] was successful in terms of audience popularity, the presentation of the game was awkward due to the need to move from slide to slide in the correct sequence. Additionally, the five question sequence for each contestant proved too long and limited participation. In fact, the biggest complaint from the capacity crowd was that not everyone had a chance to participate during the three hours that the students ran the game.

The following year a standalone application was developed for facilitating operation of the game during the Open House. Written in Microsoft Visual Basic 6.0, the game software has been a visually appealing, reliable, and easy-to-use means of conducting an activity which still depends on an outgoing, exuberant host to make it an enjoyable experience both for those participating and for those watching.

Other activities using the same or a similar name have been used elsewhere. For example, the Engineering Student Council at Cornell University held a game for undergraduate engineering students.[5] “Who Wants to be a Mechanician?” was used as an in-class teaching technique.[6] ASME student sections used PowerPoint slides to conduct a game of this sort concerned with the organization itself.[7] Companies including Bechtel[8] and Lockheed Martin[9] have used games by the same name in their outreach programs. None of these games appear intended for the format described here, nor is customizable software freely available to facilitate these games.

Who Wants to be an Engineer?

Four people are required to run the game. One functions as host, and is responsible for maintaining the flow of the game and interacting with contestants and the audience. This is the most critical element determining the success of the game—exuberance and extroversion are important. Another person assists with registration and randomly draws the names of participants, a third assists with prize distribution, and the fourth person runs the computer software.

Preparation for the game requires review (or development) of questions to ensure that they are of appropriate difficulty. The game has three grade levels: Elementary, Junior High, and High School. All questions selected were to be related to engineering in some way: mathematics, science, and engineering history were three specific subject areas suggested to question writers. Students, faculty, and staff contributed

questions (and answers). Student organizers categorized, proofed, and validated questions and answers. Categorizing questions is particularly challenging for the Elementary group, since you will potentially be asking the same question of a first grader and of a fifth grader. After the grade level is assigned for a question, the difficulty of the question on a scale of 1-5 is assigned, with 5 being the most difficult. This is by far the most labor-intensive task required to prepare the activity.

The database is a single sheet within a Microsoft Access file. The table contains a question number (a unique integer assigned at question entry), the age group (integer from 1-3, where 1 represents elementary, 2 junior high, and 3 high school), the difficulty level (increasing difficulty represented by an integer from 1-5, where in the current game format 2 and 3 are equivalent, as are 4 and 5), the question (normal text with formatting marks), the correct answer, three alternate answers, and a binary flag indicating whether the question has been used (Figure 1). Formatting marks for the text are available to allow superscripts and subscripts to be displayed. The program will automatically resize the text to fit the game screen. Detail on database formatting is available on the game web site.[10]

Once the question database is complete, the game environment must be set up. We use a small lecture hall with seating for about 100 (Figure 2). To display the game image, an LCD projector capable of XGA resolution is used. This is connected to a computer (originally a desktop PC, more recently a laptop has been used) controlled by a student in the front row. A registration table is set up near the entrance to the hall with separate forms and boxes for each age group. Due to privacy concerns, the only information collected is a first name, first letter of their surname, and the student’s school.

Prizes are distributed in three groups on tables between the projection screen and the chairs where the host and contestant sit. The prize for correctly answering the first question is typically

a pencil and a pad of paper both with the UK logo on it. The prizes available for correctly answering the second question include food coupons, lunch bags, thermal mugs, and other small items. The prize for correctly answering the third question includes t-shirts, golf-shirts, sports bags, ceramic mugs, and other nicer items. With the exception of the paper and pencil, all items are donated by local companies and industries.

The game begins by drawing the name of a contestant to participate from one of the registration boxes. The person running the computer selects the appropriate age level during this time (Figure 3). The host engages the contestant in some introductory banter before game play begins. When the host indicates readiness, the first question is displayed on screen (Figure 4). After the player indicates their answer, that selection is highlighted (Figure 5). Once the answer is confirmed as a “final answer,” the question background color changes to yellow (Figure 6). After a pause for effect, the computer operator reveals the correct answer. If the answer is correct, the background color changes to green; otherwise it changes to red and the correct answer is highlighted in green (Figure 7). Large numbers on the right side of the display indicate the current status of the game. The game continues until all three questions have been answered correctly or until a question has been answered incorrectly.

During the course of the game the contestant can use a single “Engineer’s Aide”, a poll of the audience to assist the player in selecting the correct answer. The availability of the poll is indicated on screen. Once the poll is used, the computer operator removes the “Audience Poll” marker. The poll is conducted by highlighting each answer while the audience applauds to indicate their agreement that the selection answer is correct. After all four choices have been offered, the computer operator highlights the answer which received the most audience support. The player has the option to select that answer as their final answer, or to select another option as their own.

After completing the game, the current contestant is assisted in selecting their prizes while a new contestant is called forward. All players receive a prize for the first question, since the host is instructed to do whatever is necessary to elicit a correct response from the player for that question only. If a player answers the second question correctly but misses the third question, the prize for the second question is also lost. The player can elect to not answer the third question and keep the prize already won. This element adds much to the entertainment value of the game since something is at stake if a player were to hazard a guess to answer the third question.

The program handles all routine elements of the game including random question selection, determining correctness of answers, and tracking results. A record of question use is maintained, so all questions for a particular level are used before they are recycled. This enables the game to be used for an extended period of time during public events without the repeat questions being obvious. To assist in prize distribution, results from the previous round are displayed during the transition between players (Figure 8).

The user interface for the computer operator is deliberately unfamiliar. A “point and click” interface would be unattractive for our purposes, so keyboard controls are required. The most common control keys, the space bar and “enter” key, are not utilized. Instead, the F12 key moves the game forward; the letter keys A-D highlight answers; and the number keys 1-4 confirm final answers. The reason behind the cryptic operation of the game is to ensure that every key press would be deliberate instead of rote, and keep the game flowing in a visually “perfect” manner. A flow sheet is provided to the operator indicating the key presses required at every point in the game, as shown in Figure 9.

System Requirements

“Who Wants to be an Engineer?” runs under Microsoft Windows operating systems, including (as of this time) Windows 95, 98, 98SE, ME, NT

4.0, and XP. Minimally 128MB RAM is required, though the game does perform slightly better with additional RAM available. The game will occupy less than 10 MB on a hard disk. To customize the question database, Microsoft Access 2000 or later is required. The video card and display device must be capable of XGA resolution (1024 x 768) in at least 16 bit color.

It is available for free download in three parts: the software install package, instructions on modifying the database, and the flow sheet for operating the game.[10] The author requests that those downloading the game send an e-mail indicating their interest in the game.

Assessment

The first Engineers Day Open House held at the University of Kentucky program in Paducah was well received by the community. Over 200 people took the time to register their attendance in February of 2000. One hundred students from the area registered to play “Who Wants to be an Engineer?”, representing about 50 schools in Western Kentucky, Eastern Missouri, and Southern Illinois. During both one-hour sessions, the auditorium was filled with an audience that stayed for most of the session. There was excellent response to the interaction of the host with the players and with the audience as a whole. The only complaint communicated to the author was that more people should have a chance to participate. In total, only twenty-one people were able to play the game. This Open House utilized the PowerPoint version of the game.

The following year, the computer program was used to facilitate the game. Attendance at the game was still strong, but not as overwhelming as in the previous year. Due to the change in format, we were able to accommodate 30-40 students in each of the two one-hour sessions. We currently conduct the game during a single session lasting about one hour.

Assessment performed by interviews conducted with each participant in the game in 2001 indicated that the goals of the activity were met.

The questions (designed to be answered by all age groups) asked immediately after a student completed the game were:

- Do you like engineering better, less, or the same after seeing and playing “Who Wants to be an Engineer?”
- Are you more interested in becoming an engineer since coming to E-day?
- Do you think you understand better what engineers do now than you did before coming today?
- Are you having fun today?
- Do you think you will try to attend next year?

Students overwhelmingly answered they liked engineering better after playing the game. Most also indicated increased interest in becoming an engineer after attending the Open House. The author recognizes that the fact that the students were carrying newly awarded prizes likely biases the results of the survey.

Recommendation for Improvement

A newer method of constructing questions is being applied for future databases. It is proposed that difficulty correspond to rungs on Bloom’s Taxonomy of learning. The first question would be a “knowledge” based question, requiring recitation of facts as required by most of the current question set. The second question would be “comprehension” based, requiring differentiation of similar responses, or other questions designed to test understanding of a concept. The final question would be “application” or “analysis”, requiring calculation or pattern identification.[11] It would be inappropriate to expect younger students to go beyond these lower rungs on the taxonomy.

Summary

A freely available software package to facilitate the quiz game “Who Wants to be an Engineer?” has been developed for use in K-12 engineering

outreach. The game works well for large groups, is popular with students, and anecdotally improves perceptions of engineering among primary and secondary school students.

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Biographical Information

David L. Silverstein is currently an Assistant Professor of Chemical and Materials Engineering at the University of Kentucky, assigned to the College of Engineering Extended Campus Programs in Paducah, Kentucky. He received his B.S.Ch.E. from the University of Alabama in Tuscaloosa, Alabama; and his M.S. and Ph.D in Chemical Engineering from Vanderbilt University in Nashville, Tennessee. Silverstein is also a P.E. licensed in Kentucky. He has over twenty years experience in microcomputer programming, most recently in development of a prototype automatic custom videotape editing and production device. In addition to teaching and research in interfacial phenomena, Dr. Silverstein is developing a computer framework for applying teaching styles to a multimedia computer based supplement to engineering courses. He currently serves as the Membership Chair for the Chemical Engineering Division of ASEE.

ID	AgeGroup	Difficulty	Question	Correct	Alt1	Alt2	Alt3	Used
44	1	1	An automobile typically requires this for fuel in order to r	gasoline	spaghetti	silly putty	Coca-Cola	<input checked="" type="checkbox"/>
277	1	1	What causes an object to fall to the ground?	gravity	weight of an obj	projection of an	distance the obj	<input checked="" type="checkbox"/>
278	1	1	What are the main subject(s) of engineering?	Science and ma	P.E.	English	Spanish	<input checked="" type="checkbox"/>
279	1	1	Which is a type of engineer?	All of these	Mechanical	Chemical	Civil	<input type="checkbox"/>
276	1	1	The answer to 20 divided by 4 is	5	4	6	16	<input checked="" type="checkbox"/>
58	1	1	What causes you to fall to the ground?	Gravity	Inertia	Centrifugal Forc	A sharp blow to	<input type="checkbox"/>
40	1	1	The American Flag is in the form of what shape?	rectangle	square	triangle	circle	<input checked="" type="checkbox"/>
281	1	1	What is the primary use of a ruler?	To measure thir	To rule a kingdo	For mom to whi	To make noise	<input checked="" type="checkbox"/>
283	1	1	How many days are in a year?	365	12	355	24	<input checked="" type="checkbox"/>
289	1	1	Cotton candy is made from	sugar	cotton	beets	flower	<input checked="" type="checkbox"/>
284	1	1	The sum of twenty and four is	24	21	80	42	<input checked="" type="checkbox"/>
288	1	1	Which of the following does not contain a computer chip	scissors	Sony Playstatio	calculator	computer	<input checked="" type="checkbox"/>
286	1	1	Which of the following objects is used to measure lengt	ruler	calculator	abacus	compass	<input checked="" type="checkbox"/>
287	1	1	What color is the background of a "stop" sign?	red	white	black	green	<input checked="" type="checkbox"/>
282	1	1	What is the name of one engineering field	Mechanical Eng	Nintendo Engine	Playstation Eng	Sega Engineeri	<input checked="" type="checkbox"/>
39	1	2	Nutritionists recommend you drink 8 cups of this every	water	milk	gas	air	<input checked="" type="checkbox"/>
35	1	2	Which of the following is what the earth revolves around	The Sun	The Moon	Mars	Earth	<input checked="" type="checkbox"/>
36	1	2	How many inches are in one foot?	12	6	10	100	<input checked="" type="checkbox"/>
43	1	2	Engineers are involved in which of the following?	all of these	designing bridge	designing cars	packaging food	<input checked="" type="checkbox"/>
38	1	2	If you bought a dozen doughnuts, how many doughnuts	12	10	144	50	<input checked="" type="checkbox"/>
42	1	2	A soda costs \$1.00 from a machine. How many quarter	4	3	1	2	<input checked="" type="checkbox"/>

Figure 1. The database file used to store questions for the game. The questions shown are primarily the easiest elementary level questions.



Figure 2. Who Wants to be an Engineer in its inaugural offering. Note the game display on a large screen. Prizes are set out behind the players, who are intended to be the focus of the “show.”

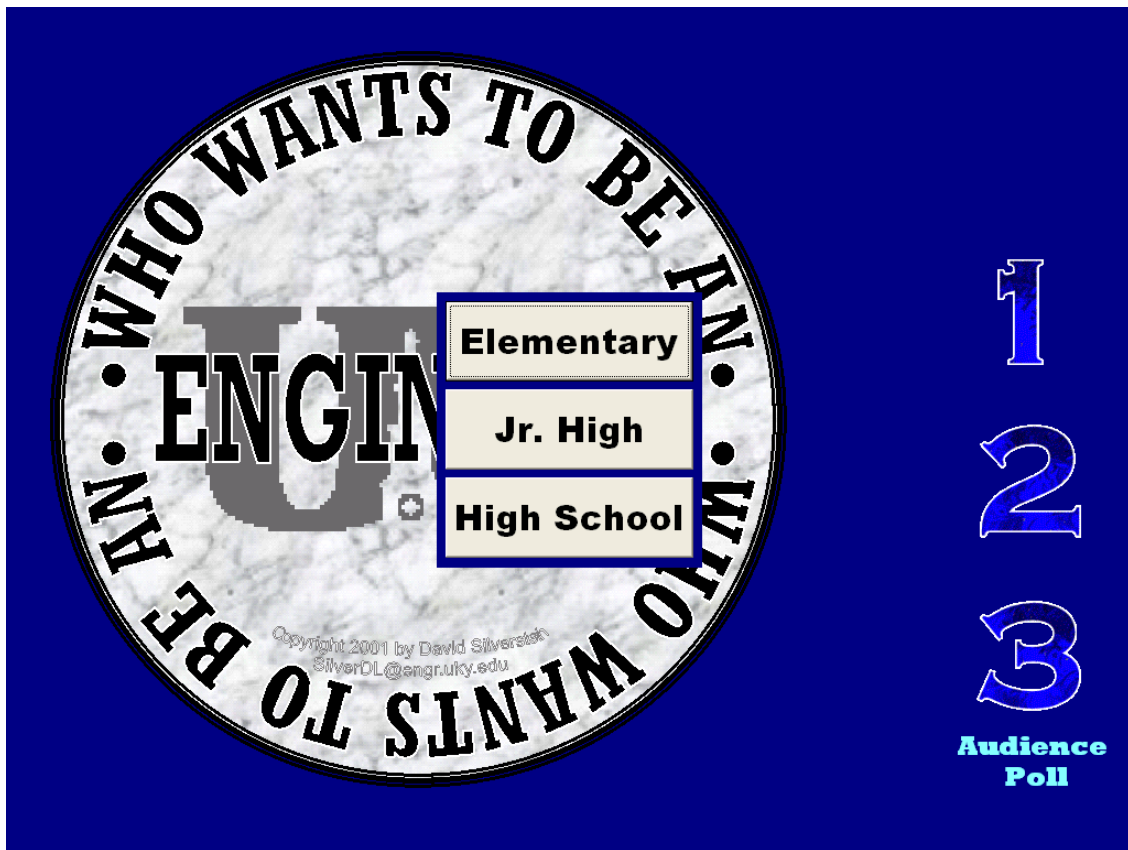


Figure 3. Level selection prior to the start of the game.

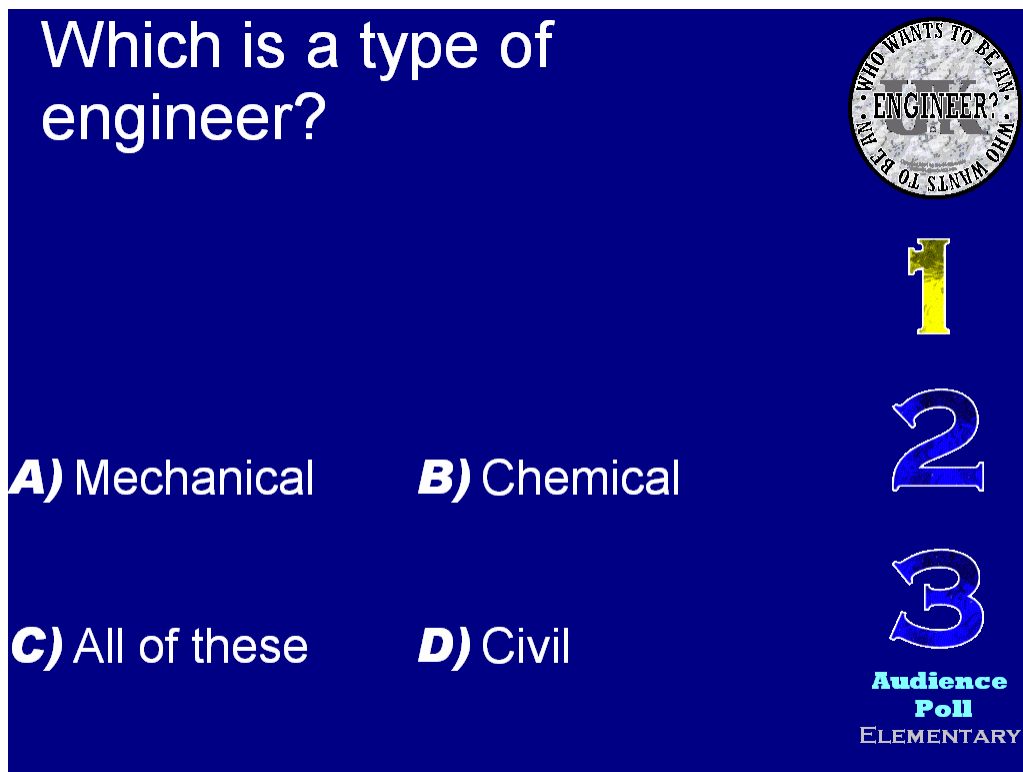


Figure 4. The first question posed to a new player.

Who made the accidental discovery of vulcanized rubber?

A) Michelin **B) Goodyear**

C) Cooper **D) Firestone**

1
2
3

Audience Poll
High School

Figure 5. A challenging final question in the high school group. The revelation of the correct answer is pending the contestant choosing a “final answer.”

Orange juice is an excellent source of which vitamin:

A) D **B) E**

C) C **D) A**

1
2
3

Audience Poll
Elementary

Figure 6. An elementary level third question, answered correctly. Making certain the difficulty of questions corresponds to the age group is the most challenging part of the game design.

The formula for the volume of a box is?

A) length* height **B)** side²

C) length* width* height **D)** 1/2 base* height

1

2

3

Audience Poll
Junior High

Figure 7. A middle school question of medium difficulty answered incorrectly. Notice the correct answer is highlighted green, and the prize eligibility is tracked on the right of the screen. The current level, prize status, current question, and audience poll availability is always on screen.

1

2

3

Audience Poll
Junior High

Figure 8. The title screen between rounds ensures that the prize distribution can be handled accurately while a new contestant is called for from the audience.

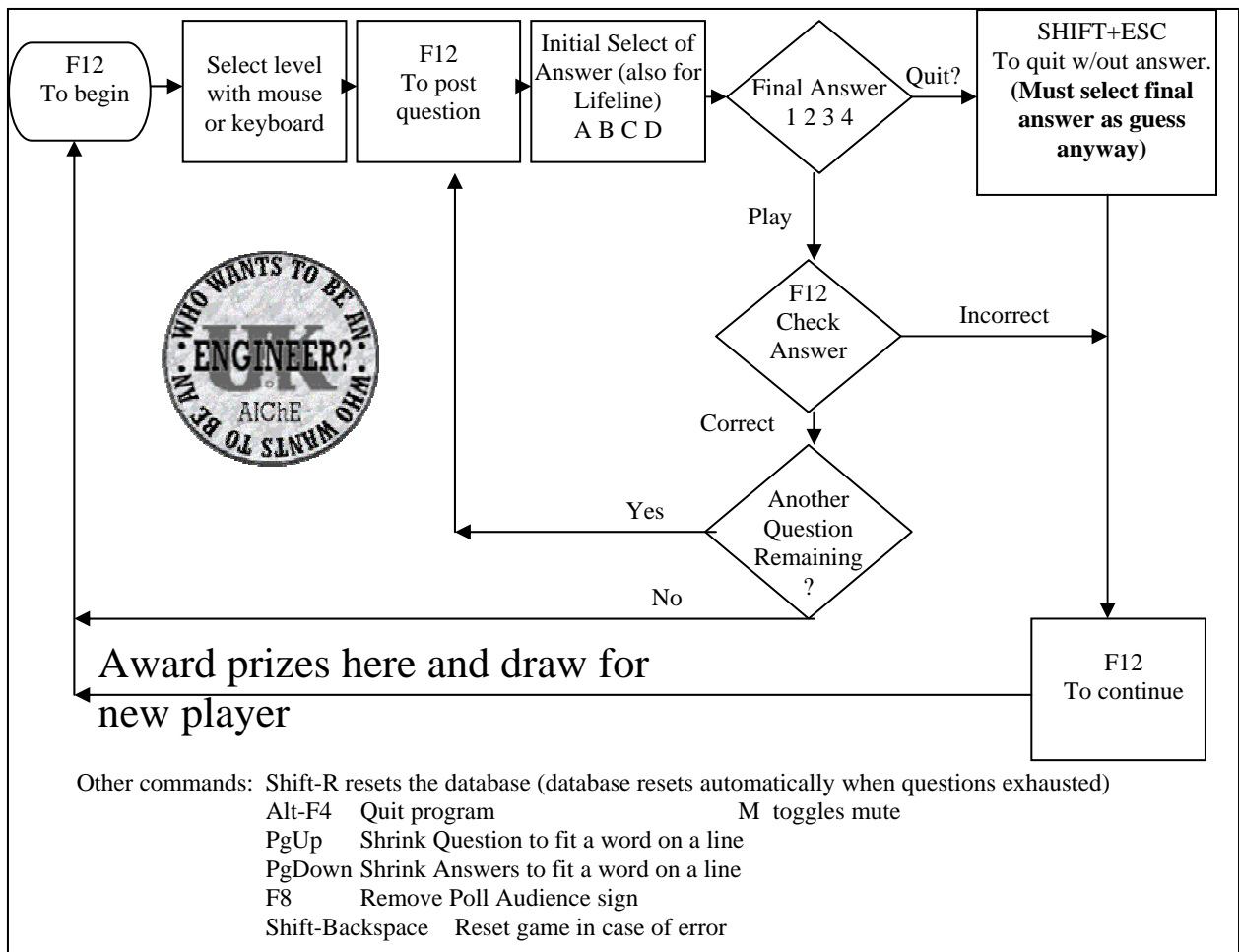


Figure 9. The flow sheet used by the program operator.