

Use of Kahoot! game for increased student motivation and understanding in a Thermodynamics course

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Abstract

Thermodynamics continues to be one of the most challenging courses in the mechanical engineering curriculum. In many cases, even capable students can become discouraged in an introductory thermodynamics course. Additionally, the dense conceptual nature of the course can make traditional lecture methods unnecessarily discouraging. This paper presents an alternate approach to conveying much of the conceptual content. In this study students were given one page reading assignments as preparation for course lectures. Then, at different times throughout the semester an online quiz game, called Kahoot!, was played during class to reinforce the content covered in the reading assignments. There are many elements in Kahoot! that can increase student motivation including competition with classmates and the included music. Students were surveyed and monitored throughout the course to determine the impact on motivation and understanding in the introduction to thermodynamics course. Several insights were gained with regards to effective use of Kahoot!.

Keywords

Kahoot!, Gamification

Introduction

Kahoot! is an online resource that combines the technology students carry with them every day and a simple quiz-style game that can be used to reinforce and explore course concepts. Students can log into games during class time for free using their cell phones or laptops. Figure 1 illustrates how the game is played. Instructor generated multiple choice questions can be shown on a main screen in the classroom and students can answer questions using their cell phones.

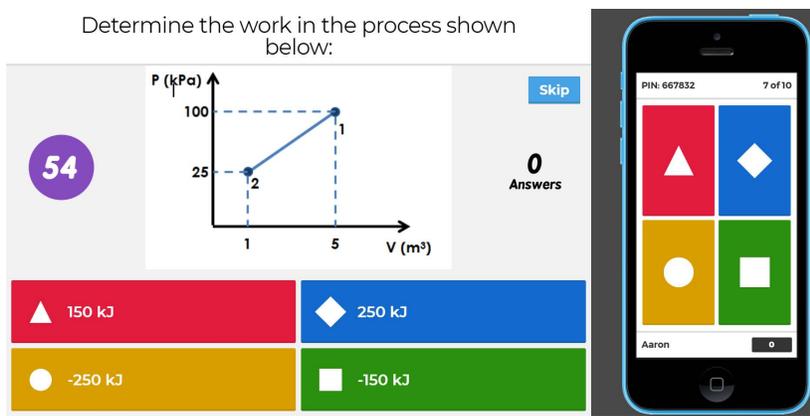


Figure 1. Sample question from Kahoot! quiz and student game screen

The use of Kahoot! has been studied in courses covering topics in physics¹, chemistry^{1,2}, engineering^{3,4}, computer science⁵, English⁶, and medicine^{7,8}. In each study a common thread of “Gamification” is discussed that describes the process of using games as a form of training/education. The mechanics of Gamification depend on the tools available, the applications being studied, and the techniques being applied, which drive the interactivity within the classroom, an increase in motivation, and rewards obtained⁹.

Kahoot! is very easy to use and has several features that are really effective in enhancing student engagement such as built in music, question time limits, top scorer updates, and interesting graphics. After each question, the correct answer is shown along with the number of students that selected each answer choice. Since the instructor has control over when to move to the next question, this provides a great opportunity for instruction. Based on the student responses, the instructor can go a little deeper in explaining a concept previously presented in the course.

This paper presents the study of introducing Kahoot! into an intro-level thermodynamics course. In an effort to take full advantage of Kahoot!, the thermodynamics course was modified slightly. A significant portion of the lecture notes was converted into one page reading assignments that the students were required to complete before the lecture. This opened up extra time during class for Kahoot! quizzes based on the reading assignments as well as other course notes. A brief student survey was conducted at the end of the course. Based on this survey and observations made throughout the course, some recommendations for effective use of Kahoot! were developed.

Reading assignments

The first course in thermodynamics requires establishing an extensive conceptual framework early in the class. Several concepts and definitions from physics and chemistry must be reviewed. Also, several new terms and definitions must be defined. Covering all this content in using traditional lecture methods has several drawbacks. First of all, very little time is left for the time consuming example problems of the course that are necessary to master the content. Secondly, students can get bogged down with the mechanics of copying down extensive conceptual notes. On the other hand, if the content is simply presented in PowerPoint slides, the students may not be able to sufficiently comprehend the concepts.

A semi-flipped approach was used in this study to alleviate these issues with traditional lecture methods. The approach was to combine Kahoot! quizzes with outside reading assignments. The challenge with using outside reading assignments is getting the students to participate. A strategy used in this study was to limit the outside reading assignments to a single page. A single page reading assignment was posted for about half of the course lectures. Further, in class Kahoot! quizzes based on the reading assignments were conducted on the day that the students were expected to complete the reading assignments. Many students would complete the reading assignments right before class. This method gave the students an opportunity for immediate feedback on their understanding of the concepts presented in the reading assignment.

Covering many concepts in the lecture readings also had several benefits for the remaining traditional lecture portion of the course. With much less content to cover, the instructor was able to spend more time on challenging concepts. Also, this approach left time for a higher number of complex multi-step problems to be solved in class.

Student surveys

A voluntary online survey was created to gauge the students' perception of playing Kahoot! quizzes during class. Of the 28 students in the course, 20 students participated in the survey. The results for the multiple choice questions are summarized in the Table 1. The results indicated that the general student perception was positive. The second question received the most "strongly agree" response. While the response on the other two questions were still positive, there were less "strongly agree" responses. This may indicate that there is some room for improvement in the areas of conceptual benefits of the quizzes and student engagement.

Table 1. Summary of Student Survey Responses

	Strongly Disagree	Disagree	Agree	Strongly Agree
The Kahoot! quizzes have helped me understand concepts better in this course	0	0	13	7
Playing the Kahoot! quizzes was fun. I always looked forward to playing.	0	1	10	9
I tried really hard to get the right answer on the Kahoot! quizzes	0	0	17	3

In addition to the multiple choice survey questions, the students were also asked to give additional comments. One of the major themes in the comments related to students emotional experience of the game. Many students mentioned that the quizzes were fun and one comment mentioned that the quizzes were a "great way to break up the monotony in class". However, other students mentioned that they felt stressed during the Kahoot! quizzes, but they still felt that the quizzes were helpful tools to prepare for tests. Another theme that emerged in the student responses was that the quiz provided helpful feedback and opportunities to reinforce conceptual areas where the students were unsure. A third major theme related to question length. A couple of students mentioned that the time limit on some questions was not long enough. Other students mentioned that they got discouraged with longer questions that required looking up information or doing detailed calculations.

Effective use of Kahoot!

A number of observations were made during the semester with regards to effective Kahoot! questions. As discussed above, well designed Kahoot! questions can lead to better student engagement, motivation and learning. However, poorly designed questions can have the opposite effect.

For example, there are several issue related to time that must be considered. First, choosing an appropriate time limit for each question is essential. Giving too little time seems unfair and brings frustrated students to give up and disengage. Allowing too long can leave several students bored and can diminish the fun atmosphere created by the game. The instructor should be careful to make the time limit long enough for the students to read the question and all of the answer

choices and have a little more time to think about it. Even if the right amount of time is given, however, the quiz can still lose impact if too many long questions are used. In one of the Kahoot! quizzes used during the semester three questions in a row were given that allowed 120 seconds each. These questions required looking up information from tables and doing some calculations. The instructor observed that the quiz became a much less engaging experience for the students. Additionally, some students would just guess since they did not want to put the effort into the longer questions. Based on these findings, student motivation is more easily maintained when questions requiring 60 seconds are used sparingly in between several shorter questions. Figures 2 and 3 show examples of short and long quiz questions that were used in the study.

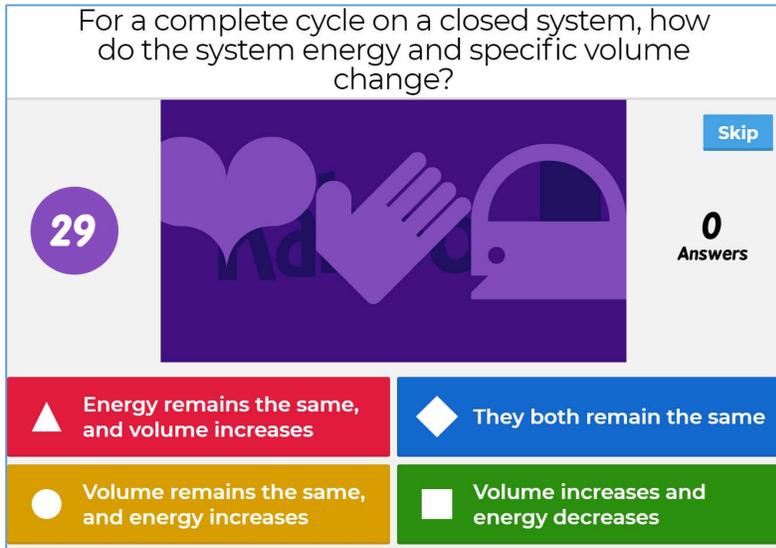


Figure 2. Example of shorter quiz question used in the course.

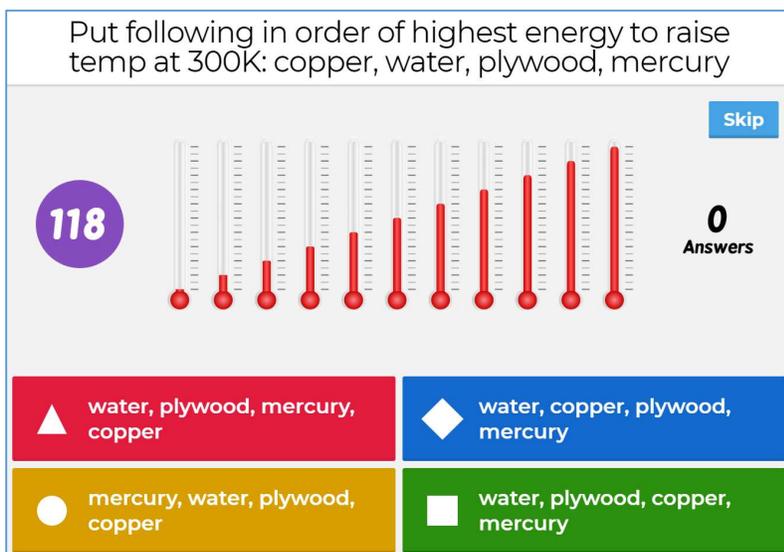


Figure 3. Example of a longer quiz question used in the course.

In addition to considering the time limit, the difficulty level of the quiz questions is also a critical issue to consider. Several times the instructor observed students getting discouraged with multiple failed attempts to answer questions correctly. Students who are unprepared should expect to miss most of the questions. However, the questions should be designed so that an engaged student can get the majority of the questions correct. Based on trial and error, an effective approach discovered was to start with a relatively easy conceptual question and then reintroduce the same concept later in the quiz with more complexity. Figure 1 shows an example question that evaluates the students understanding of how work is defined for a simple compressible system. With enough time, most of the students were able to get the magnitude correct. However, several students selected the answer with the wrong sign or units. Notice that the process is a compression process. Most students will not have considered what makes the work positive or negative before this point. Seeing the answer to this question was a real “ah-ha” moment for many of the students. The learning is reinforced when the student has an opportunity to apply their new understanding. Therefore, another question was placed later in the quiz (see figure 1) that built on this same concept but was also a little more challenging. This gave the students an opportunity to apply what they learned in a meaningful way. The instructor observed a high level of satisfaction from several students who were frustrated on the earlier question.

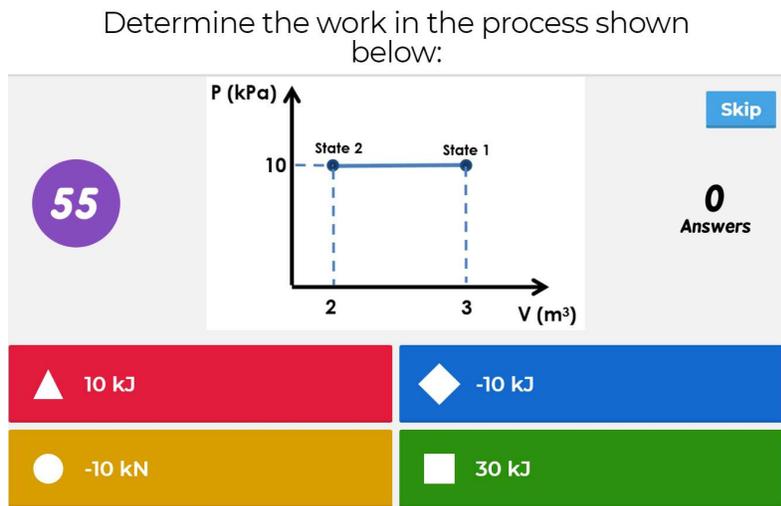


Figure 4. Example quiz question on find work as area under P-v curve

Summary and Conclusions

This paper has presented the study of using Kahoot! in combination with reading assignments to improve students motivation in a introduction to thermodynamics course. The survey responses and instructor observations revealed several positive elements with regard to the student motivation. Also, the study revealed the importance of appropriate question length and difficulty. One area of interest for future study that surfaced was the use of embedded videos in the Kahoot! quizzes. Kahoot! has a feature to allow questions based on embedded videos, and this feature was used some during the course with mixed results. This may be a good way to bring narrative elements into the classroom to greater enhance student motivation and engagement.

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