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Use A Course Structure Chart in Gamification in Higher Education

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I. INTRODUCTION

Educators are always facing the challenge of how to motivate their students, especially when lifestyle changes occur [1]. Although COVID-19 does not affect daily life as it did during the pandemic, education systems, especially college education, face significant challenges as the first group of students who took their high school classes online due to the pandemic begin their college studies. During the pandemic, most students took a long time to become familiar with the transition to online education. For the same reason, students now need more time to adapt to face-to-face education.

Paper textbooks have been replaced by electronic textbooks (eBooks), which offer many advantages but also raise several problems in education. The advantages of online learning platforms, such as Brightspace, have made them widely used in college and K-12 education, especially during and after the pandemic. These platforms facilitate a smooth transition from K-12 to higher education and provide a flexible learning environment for students with different learning styles. However, online learning platforms also present some challenges.

All these new transitions affect not only teaching methods but also students' attitudes toward studying. Therefore, college education, an important period and a potential starting point for a professional life, must adapt to these changes to prepare qualified professionals for the future.

Gamification is the process of adopting game elements into educational activities, and has shown to be a popular idea for motivating students, especially for most college students born in this modern information age [2] . Most studies show that incorporating gamification in higher education makes learning more engaging and enjoyable for students. It provides different ways to recognize student achievement and challenges students to move forward [2 – 4].

However, early adopters of gamification are mostly computer science/IT educators [4]. It is a significant challenge to adopt this idea in theory courses, such as Analog Signal Processing, which play crucial roles in higher education because these courses are foundational in every field. One reason is that theory courses often rely heavily on mathematical tools, such as the Laplace transform, which can confuse and discourage engineering students.

A common problem in theory courses is that most students do not know when and how to use these mathematical tools. There are several reasons for this. Some students do not enjoy mathematical material and try to avoid it. Others separate mathematical concepts from the engineering field, believing that engineering is solely related to hands-on work. Additionally, most textbooks separate theory and applications into different chapters, making it difficult for students to grasp the course’s overall structure.

This work is part of an effort to adopt gamification in a theory course, Analog Signal Processing, a core course in Electric Engineering and Electric Engineering technology program. A course

structure chart is used as a progress map in gamification. The paper is organized into the following sections: Section II discusses some challenges in theory courses. Section III presents an example of a course structure chart used in gamification. The conclusion is provided in Section IV.

II. CHALLENGES IN THEORY COURSES

There are many problems in education systems nowadays when different methods are used to solve various issues. Different groups in different fields face different challenges. This section discusses some problems that the author encountered in several theory classes in recent years.

Textbooks: Although textbooks are important study materials, most students do not have them. Expensive textbooks often pose a problem for students. Most public schools do not provide paper books to students in K-12 education. For cost reasons, eBooks or complementary materials in electronic formats, such as teacher notes or PowerPoint files, are widely used. This makes the new generation pay less attention to textbooks, which lowers student performance according to some studies [5, 6]. A study by neuroscientists at Columbia University's Teachers College shows that a clear advantage of reading a text on paper is for "deeper reading," while "shallow reading" was observed on a screen [6]. Although some other studies show more advantages of using eBooks, reading on screens may be one of the factors causing the nationwide decline in reading scores among American youth. The lack of visual stimulation from physical books from a young age contributes to this issue. Some students think they do not need a textbook. Additionally, electronic devices for eBooks, such as laptops, frequently distract students in class.

Attendance: Because most instructors post their class notes, slides, and even class videos on online learning platforms, some students treat in-person classes as optional, even when their instructors have attendance requirements. Furthermore, all these virtual study materials never give students a complete picture of how much information has been and will be covered in class and the relationships among all the course material. Some students never realize how attendance affects their performance.

Knowledge Buildup Process: According to Bloom's Taxonomy of Learning [7], knowledge should build up over time. Most college students take 4 to 5 courses simultaneously. All courses present new material to every student, and students typically accept the new knowledge passively through memorization. To freely use what they have learned may require more time. Therefore, for some students, the material learned in one course is almost separate from others, even though they are related. All isolated knowledge is easily forgotten, which causes some students to lose interest, a key factor in motivating students to study [8].

Regardless of the education system used, the best solution is the one that meets the needs of students with different learning styles as much as possible. Although there is no perfect solution, changing teaching methods according to the student background in class usually leads to better results. The following section describes a course chart used in an Analog Signal Processing class after the author took the "Course Gamification with Brightspace Features" course, which is mainly to help faculty adopt Brightspace features to motivate students. The method aims to help

students remember the material as quickly as possible at the beginning and also is used as the progress map in course gamification.

III. THE COURSE STRUCTURE CHART

A progress map as shown in Fig. 1 in course gamification originally resembles a cartoon picture. It is used to help students realize their achievements or journey throughout the course. It provides a visual reflection for students, showing not only how much work they have completed but also how much work remains, similar to playing a game. Normally, it is not related to any specific course material.

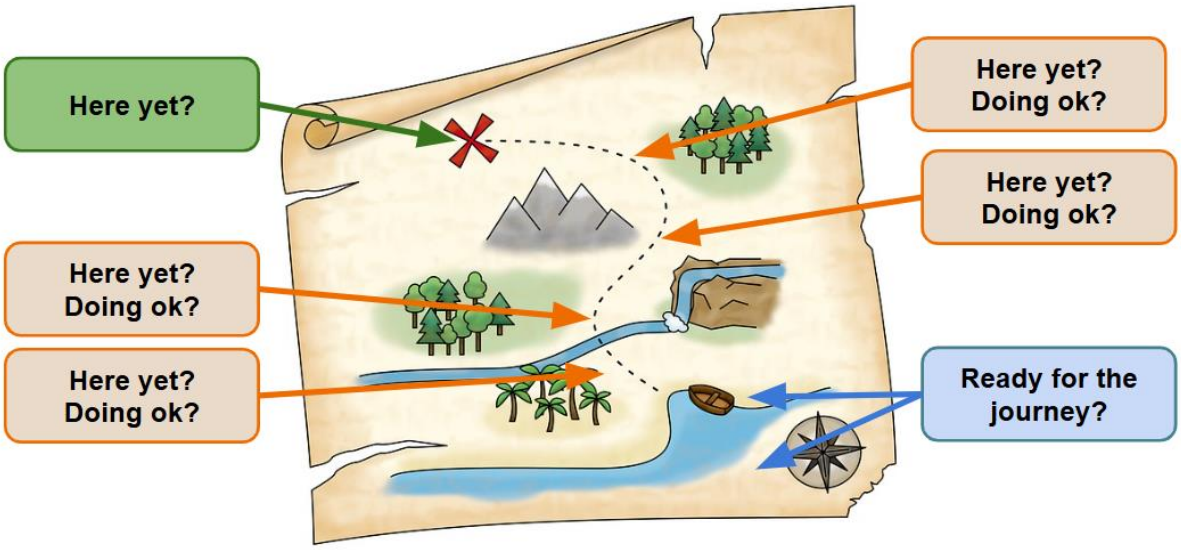

Fig. 1 A Progress Map in Gamification

Using flowcharts to summarize course material helps students remember and use the content [9]. The author used the concept of a flowchart to create a course structure chart, as shown in Fig. 2, when teaching Analog Signal Processing, a mathematics-based theory course. The chapter numbers in Fig. 2 are based on the assigned textbook for the course [10]. A common problem in class is that some students forget the material they have learned after chapter tests because they think, "This chapter is over." They face trouble when they need to use the material in subsequent chapters. Normally, they do not know what kind of information should be reviewed and used in the new chapter when they encounter a problem. For example, they have fewer problems figuring out the Laplace transform and inverse Laplace transform when they first learn it. However, they do not know how and when to use the Laplace transform and inverse Laplace transform in circuit analysis and circuit design in later chapters. As shown in Fig. 2, the course structure not only helps students remember the course material but also illustrates the relationships among all the content. It demonstrates the sequence of knowledge buildup, similar to the course journey in gamification.

The course structure chart was issued to students at the beginning of the class. Meanwhile, the chart is also used as the progress map posted on Brightspace when gamification is adopted in the

class. All unlearned material is covered by picture blocks, as implemented in gamification, and the block is removed after students learn that section.

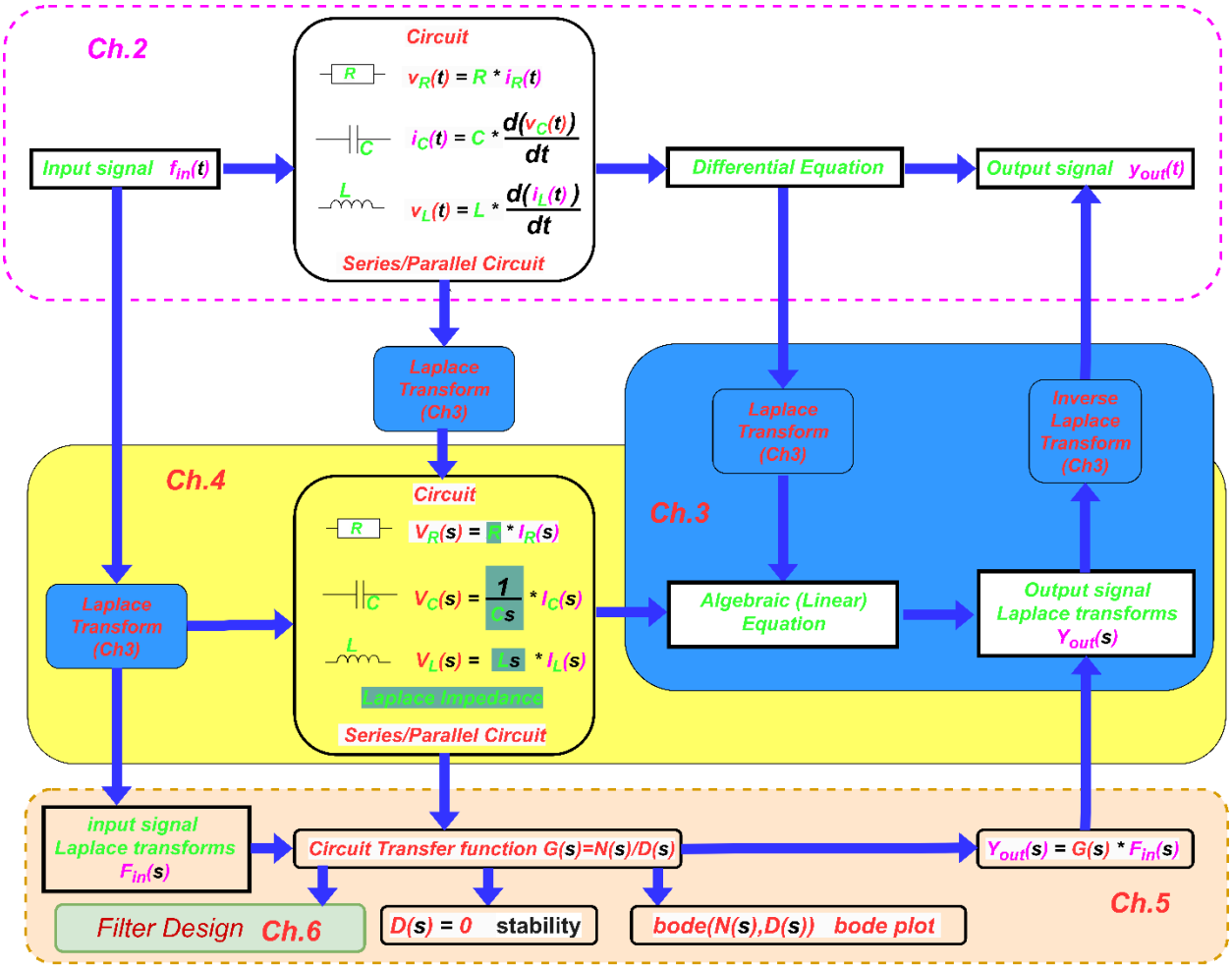

Fig. 2 A sample of the course structure chart

According to the author's observations and student surveys, this chart not only implements the progress map function in gamification but also helps students improve their performance. At the beginning of the class, most students realized that a textbook is required after they frequently read the chapter numbers on the chart. According to the author's observation, the number of students owning and using the assigned textbook increased. Whether they use paper books or eBooks, the chart helps students quickly locate references. If they miss any class, the chart also guides them to make up the course material that will be used in the coming class. Because the chart lists the related information directly from the textbook, it encourages students to use their textbooks frequently, which helps them memorize course material.

Most of the time, students try their best to memorize or study new materials. However, it can be challenging for them to see the relationships between different concepts, which limits their ability to use what they have learned to solve real problems. This is one reason why some

students have lower application abilities [7]. The chart clearly shows the course materials and their relationships, guiding students to apply what they have learned to problem-solving. For example, different analog signals are introduced at the beginning of Chapter 2. These signals can be used as input or output signals, although an output signal results from complex mathematical calculations based on circuit theorems using the given input signals, as introduced in the following sections. Some students are confused by the sequence in which the course material is delivered, and they think that the format for an output signal should be different from that of an input signal, especially when the Laplace transform and inverse Laplace transform are used in following chapters. When the course chart is used as the progress map, the same picture blocks are used to represent the input signal $f_{in}(t)$ and the output signal $y_{out}(t)$. These blocks are removed simultaneously after different analog signals are introduced at the beginning of Chapter 2. This demonstrates to students that there is no difference between input signals and output signals in terms of their mathematical format, and therefore, the same transformation can be applied to both.

In most theory courses, mathematics is frequently used, which can be a significant challenge for engineering students. Some students think that they should not take this "math" course even though it is a core course in the engineering field. Some students are intimidated when they see complex math equations or symbols. These factors discourage students at the beginning of the class, leading to low performance at the end of the semester. Some students always struggle with understanding the relationship between mathematical material and engineering material, which the chart clearly shows. For example, Fig. 2 illustrates that the Laplace transform in Chapter 3 is a crucial mathematical tool for analyzing and designing circuits, and students must try their best to grasp the material.

At the end of the semester, student performance is evaluated according to their final grades, as shown in Fig. 3. If a student receives an A or B, their performance is marked as high. A C indicates middle performance, and a D is treated as low performance. The orange line shows student performance when gamification was not adopted in that group, while the blue one shows student performance after gamification was adopted.

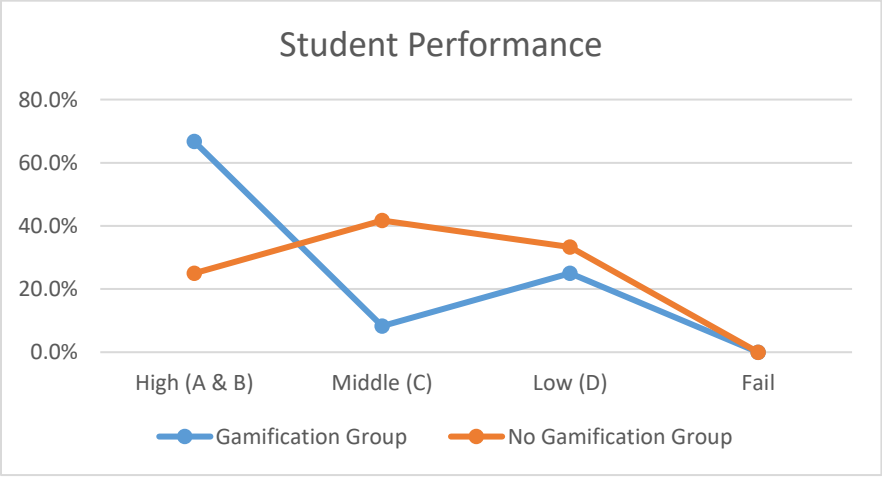

Fig. 3 Student performance

In Fig. 3, it appears that without gamification about 67% of the students performed High (25%) or Middle (42%) and about 33% performed Low, while with gamification about 75% of the students performed High (67%) or Middle (8%) and only about 25% of the students performing Low. Apparently, student performance increased. Some students' comments, such as "I like the chart," indicate that the course structure chart plays a significant role as a progress map in gamification.

IV. CONCLUSION

This paper explores the use of the course structure chart as a progress map when gamification is adopted in a theory course. The method was implemented in one group and evaluated based on students' feedback and their final grade. For this small sample, the data shows an overall shift towards better improvement. Besides the function of the progress map in gamification to motivate students, the course structure chart helps students in their self-studying. Future plans include implementing the method in different courses to further evaluate its effectiveness.

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