Train-the-Trainer: Gamification for Coding

Design Project - Curriculum Guide

http://etec510-gamification-coding.me

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What is "Train the Trainer: Gamification for Coding"?

Welcome to our learning environment prototype called "Train the Trainer: Gamification for Coding"! As an educator, you must have heard that gamification continues to be a hot trend in learning. You may have asked yourself, "how do I integrate gamification into the classroom and what do I need to do?". Our goal is to support the integration of gamification for Grade 6-12 educators teaching Applied Design, Skills, and Technologies (ADST) and Computer Science (CS). This design prototype:

- Provides resources that focus on bridging the gap between theory and practice
- Explores the various ways in which game design elements and approaches could be situated into real learning scenarios, as well as instructional design theories that leverage game mechanics
- Incorporates gamified platforms specialized for computer programming and other general-purpose game-based tools
- Offers an instructional lesson plan featuring the use of game mechanics to guide educators how to gamify their lessons. There is also a complete gamified learning module called "The Bee-Bot Mission," featuring gamified activities and assessments which demonstrate the application of gamification into teaching ADST/ CS curricula.

Why Gamification for Coding?

Computation is everywhere; from search engines that help us find information, to cash registers in stores, to software used for designing educational content, we live in a world built on the effects of computation. Currently, the required knowledge and understanding of computing is deeper and more complex than most people's ability to use technology. Professionals in every discipline need to employ computing to function and thrive in a globally competitive environment . This reality is the impetus to provide opportunities for introducing computer science to young learners.

The idea of teaching youth to code isn't new. Seymour Papert, the mathematician, computer scientist, and educator argued as early as 1968 that computing could be a vehicle for learning (Schofield, 2016). However, computer science education has been hampered by the perception that it focuses exclusively on programming. This misconception has resulted in K-12 curricula that were exceedingly limited in scope and negatively perceived by students (CSTA, 2011). In an attempt to address these concerns, the CSTA (Computer Science Teacher Association) Standards defined five complementary and essential content "strands" for developing curricula for CS education. The five strands, which are generally independent of a learner's grade level, are shown in the following figure:

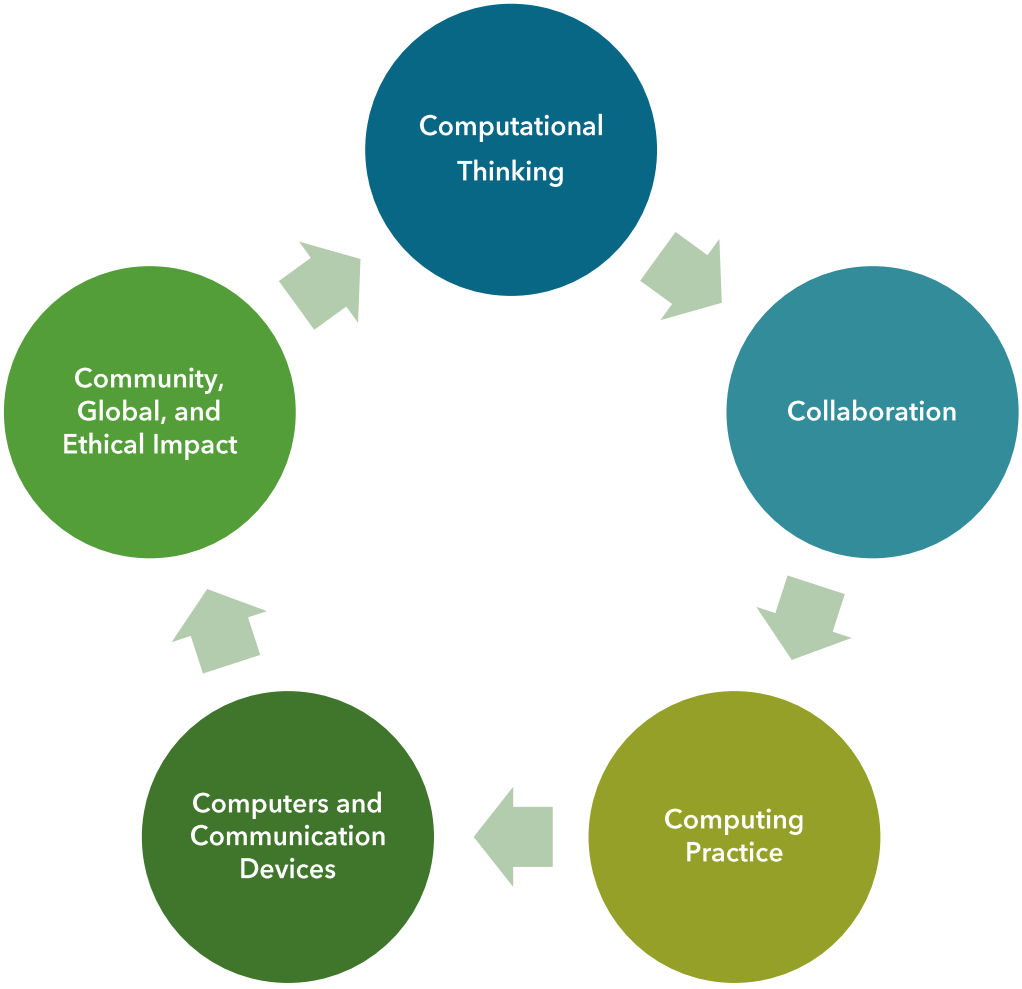

Fig 1: CSTA Content Strands

The work of the Association for Computing Machinery (ACM) and the Computer Science Teachers Associations, long-time proponents of teaching K-12 students to code, have opened the door to a vision of learning where the principles of computer science education are fundamental skills for everyone, not just computer scientists. The new BC curriculum has endorsed that all learners engage in the concepts and practices of computer science. From Grades K-12, learners will develop a foundation

of computer science knowledge, learn new approaches to problem-solving that harness the power of computational thinking and become both users and creators of computing technology. By applying computer science as a tool for learning and expression in a variety of disciplines and interests, students will actively participate in a world that is increasingly influenced by technology (BC Ministry of Education, 2018).

Teaching computer science, particularly to youth, is difficult. The subject might be considered boring and may be regarded as analogous to teaching a foreign language, mathematics, and logic in the same lesson. Youth are not particularly fond of those subjects (Behnke, 2015). For many years, educators have struggled to provide students with engaging methods for learning basic computational concepts, which are "often hard to teach and learn" (Fotaris, Mastoras, Leinfellner & Rosunally, 2016, p.97). Learner disconnection, disengagement, and alienation are likely outcomes of deploying traditional approaches to teaching computer science (Fotaris et al., 2016). As young learners continue to actively interact in gaming spaces (Behnke, 2015), gamification offers a promising approach for increasing student interest, motivation, and engagement in learning computer science (Behnke, 2015).

What is Gamification?

Gamification is defined as the "use of game elements within non-game contexts" (Deterding, Dixon, Khaled & Nacke, 2011, p.1). The approach has received increased attention in recent years (Hung, 2017). Figueroa-Flores (2016) identified potential benefits of integrating games into learning including the freedom of failing, immediate feedback, increased motivation, personally-defined goals, and authenticity.

Evidence of Success

Several empirical studies were conducted to examine gamification in computer science (CS) programs with many revealing positive outcomes on learning (Hung, 2017). The successful implementation of Kaplan's experiment with gamification in an entry-level programming class from the School of Information Technology "proves it can be done" (Shane, 2018, para.3). The university used badges and level advancement as a visual reward. They reported that ambition to be a top-ranking learner had been heightened by the use of gamification strategies, which in turn have increased learners' motivation and engagement (Shane, 2018).

How to Enact Meaningful Gamification?

There is a need to promote intrinsic and extrinsic motivation in learners (Fotaris et al., 2016). These motivations are, in combination, crucial for effective learning outcomes. Rewards-based gamification, solely using badges or points, can have limited or short-term effectiveness at best. For long-term effectiveness and for sustaining intrinsic motivation, there is a need to consider elements based on "Meaningful Gamification" which is defined as " the use of gameful and playful layers to help a user find personal connections that motivate engagement with a specific context for long-term change. " (Nicolson, 2015, p.1). Nicolson developed a meaningful gamification framework based on six elements framed by Deci & Ryan's (2004) self-determination theory and Universal Design for Learning (UDL). The six elements of this framework include:

Element	Brief Explanation
Play	Allows learners to explore without being penalized.
Exposition	The game must be tied more closely with the learners' real-world identities.
Choice	Provides learners the control over what they want to learn, how they want to learn, and what assignments they want to complete.

Engagement	Employs game elements that allow opportunities for both content and social interaction. The gamified system can offer increasing and differing levels of difficulty that will enable the learner to work at their own pace. Engagement within a gamified system can be enhanced using collaborative and competitive approaches.
Feedback	Provides constructive feedback that help the learners to improve their learning.
Reflection	Allows the learner to think about their learning experiences, connect these experiences with their lives, and share these insights with their peers. Nicholson (2015) suggests three components to reflection: **Description:** Learners think about the activity and share these thoughts with their peers **Analysis:** Learners making connections to their lives **Application:** Learners apply what they learned to a different context

What is this Guide?

This guide is structured to provide the various ways in which game design elements and approaches, and applications could be situated into teaching some of complex and dry learning objectives/ content organized around CSTA content stands as well as the big ideas of ADST 6-9 Curricula, Computer Studies 10, and Computer Programming 11-12.

Who is this Guide for?

Though this guide is targeting ADST/CS educators who wish to harness the motivational power and pedagogical value of gamification, consequently achieving the five CSTA content strands and competencies required in the new BC curriculum, any educator may use this guide to create custom content tailored to their curricular needs.

How to Use this Guide?

This guide is designed to provide a structure to your journey throughout our learning environment, but how you use this guide as educators is up to you. Through various online collaborative spaces provided to our community of educators, you will have an opportunity to share your journey through our platform and in your practice with your peers and with us. This includes sharing your reflections, resources or posing questions to the community forum. There will also be an opportunity to participate in a feedback survey embedded into

the learning environment to determine participant satisfaction and to assess the entire learning experience.

Technology Requirements

Considering our users will have diverse backgrounds and skills in gamification, we have designed our learning environment prototype to be accessible and easy to use, with minimal technical requirements. Accessing our site requires at least an internet connection and an internet-friendly device. This prototype is a cross-platform learning environment, so that content can be presented on various devices and browsers. Instructions will be provided for some of the guided activities which employ gamified platforms specialized for computer programming and other general-purpose game-based tools.

The Learning Environment

Our learning environment is composed of an interactive website, a prototypical lesson plan, recommended gamification platforms , and an embedded learning module. We incorporate two types of gamification: structural gamification and content gamification. Structural gamification is the "application of game elements to propel a learner through content with no alteration or changes to the content" (Kapp, Blair, & Mesch, 2014, p. 55). In this approach, the learning content does not become game-like, but the structure around the content incorporates gaming elements (i.e., badges, points, progression bars, etc.). Structural game elements are used in the design of our learning environment website. In particular, embedded badges are incorporated at the end each section of the site to motivate learners to engage in the process of learning. Content gamification, which was selected for informing the design of the learning module, is defined as the "application of game elements and game thinking to alter content to make it more game-like" (p. 55). According to Kapp, Blaire & Mesch (2014), content gamification must incorporate seven elements which we hope we applied in our design: narratives, challenge, curiosity, character, interactivity, feedback, and freedom to fail.

A. Interactive Website

The website is built on the growingly popular "WordPress" platform. The site hosts digital teaching and learning spaces targeted at ADST/CS educators who would like to refine their teaching skills in coding. It is divided into seven sections:

- **Home**: An overview of the purpose of the learning environment and a set of guidelines and instructions for the participants.
- **Register**: Participants are required to register in order to personalize their experience, to be able to earn badges, and track their achievements throughout their learning journey.
- **Foundation**: This section aims to provide a foundational background about gamification
- **Design**: This section explores the requirements for designing gamified content, including incorporating learning theories, gamification approaches, platforms, and recommendations.
- **Application**: This section aims to bridge the gap between theory and practice via a featured lesson plan and the gamified learning module, i.e. the "Bee-Bot Mission." This section also includes pre-assessment and post-assessment surveys that are designed to help participants assess their readiness in the gamification of CS education. A prototypical lesson plan will advise educators on how to apply educational theory in designing games and to improve the effectiveness of learning through gaming.

- **Community**: This section will serve as a community of practice, spaces to collaborate, share ideas and resources, discuss, and debate topics related to the aim of the learning environment.
- **Feedback Survey**: At the end of the experience with our platform, participants have the opportunity to complete in a multidimensional feedback survey, which will help us continually improve the learning environment in the future.
- **References**

Regardless of registration, participants also have the ability to reflect and share their practice with other peers through many activities and discussions on the site and through the "General Discussions" forum available in the "Community Cafe" page. Moreover, participants earn badges simply by completing the required tasks.

B. Gamification Platforms

Gamified activities include some well-known applications, such as Scratch or Hour of Code. Alongside these applications, there are activities based on innovative and novel constructivist approaches in the teaching of coding. These featured applications will be grounded on curricular competencies (context, definition, ideation, prototyping, testing, making, and sharing) and content defined in the new British Columbia curriculum for K-12 ADST/CS learning (BC Ministry of Education, 2018). Moreover, the applications are informed by the goals of the CSTA Standards framework for computer science education, complementary content strands (Behnke, 2015), and Bates (2015) modified SECTIONS Model.

C. The Bee-Bot Mission: Learning Module

The Bee-Bot Mission is a dynamic, intuitive, learning module which aims to demonstrate the application of gamified coding and to provide instructors with interactive, self-directed learning activities that can build upon their teaching skill set. The "mission", as coined in the learning environment, aims to cover three key learning objectives from the "Computational Thinking" module in the ADST curriculum. These include:

- "Software programs as specific and sequential instructions with algorithms that can be reliably repeated by others
- Debugging algorithms and programs by breaking problems down into a series of sub-problems
- Programming languages, including visual programming in relation to text-based programming and programming modular components" (BC Ministry of Education, 2018)

The design of the Bee-Bot Mission features a gamified approach to content. Moreover, the learning module resembles a game, including a narrative structure, the freedom for participants to fail and instant user feedback. This is particularly useful for learners that have no previous experience in programming, as these elements can inform their learning process. Traditional learning technology terminology is replaced by metaphors typically found in video games, such as missions, quests, boost fights, and a journey book, as described in the table below:

Traditional Term	Gamification Terms
Modules Overview	Roadmap
Learning units (Big Ideas)	Missions
Learning Activities	Quests
Online quizzes	Boss fights
Projects	Epic- Quest
Reflection	Journey Book

Assessment Model

A. Pre-Assessment Surveys

The goal of assessment in our learning environment is to drive learning and provide feedback, which can help enlighten and enhance future learning and improve educator readiness in integrating gamification into their teaching practice. Educators are encouraged to participate in a pre-assessment survey determining their readiness in integrating gamification into their practice. Subsequently, they will also be encouraged to complete a post-assessment survey, providing feedback on the learning environment and any reflections on their practice.

B. The Bee-Bot Mission: Assessment Techniques and Details

The Bee-Bot Mission features several opportunities for assessment. These include:

- Demonstrating immersion through learning activities/quests
- Undergoing a challenge by engaging in an online quiz/boost fight
- Writing self-reflections about their learning experience in their journey books

Throughout these assessments, participants are provided feedback to indicate either their level of completion of the learning objectives, or constructive hints to tell them how they are progressing. A critical component of developing mastery

is by learning from failure. Accordingly, participants can attempt any activity in the learning environment as many times as they wish. At the end of the Bee-Bot Mission, there is a tiny epic quest/project involving the implementation of functionalities of the Bee-Bot in Scratch which participants have the opportunity to complete in groups. In this tiny epic quest, participants will develop their own version of the Bee-Bot application and set their own goals, allowing them to integrate the knowledge they acquired through the learning module in a meaningful way. The tiny epic quest can be evaluated using a detailed grading rubric. Finally, participants are encouraged to self-reflect when they complete the quest.

C. Post-Assessment Survey

After completing the learning module, participants will be directed to a post-test assessment where they will evaluate their subjective experience related to the given activities. Responses will help them assess their readiness for integrating gamification into their teaching practice.

Feedback Survey

The feedback survey aims to evaluate dimensions of learning and design for the "Train the Trainer: Gamification for Coding" learning environment. Responses will be used to make timely corrections and improve its design to meet the needs of educators and any other stakeholders. There may also be an opportunity to

perform a longitudinal study to analyze feedback over a period of time, from a baseline of perceptions, knowledge, and experience evolving over different time dimensions.

Conclusion

There are many exciting opportunities for future work related to both gamification and CS education. As you have seen and experienced, gamification is an effective way to help students engage in complex subject matters, particularly when you employ the appropriate elements and techniques, reiterate and revise your gamified content, and learn about the emerging designs and frameworks employed to inform its incorporation into education.

Educators may not be able to do this by themselves. Connecting and collaborating with a community like ours can support them, giving them a step ahead, and opportunities for continuous improvement in non-traditional approaches of teaching CS education such as gamification. “Play is an important tool for learning in both nature and society” (Behnke, 2015, p.250). Understanding the nature of play, particularly game-related educational interventions, is a critical step towards the successful adoption of computer science in all kinds of educational spaces (Behnke, 2015). We hope the interactive learning environment, learning module, lesson plan, and the curriculum guides support your work in integrating the gamification of coding. More importantly, we hope you will take advantage of the discussion groups in our Community to seek advice and feedback from your peers. The collaborative learning process of ‘thinking together’, we argue, is what essentially brings Communities of Practice to life (Pyrko, 2017).

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Appendix 1

Abbreviations Used in this Guide

ACM: Association for Computing Machinery
ADST: Applied Design, Skills, and Technologies
BC: British Columbia
CS: computer science
CSTA: Computer Science Teachers Association
UML: Universal Design for Learning