

## 93 DESIGNING A GAME MODE FOR ONLINE LEARNING ENVIRONMENT

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### ABSTRACT

There is an ever increasing buzz about using computer games in educational settings. However, there are barriers that we need to overcome to design and adapt games in order to use them in a productive way as a part of formal education. ViLLE is a learning environment which combines several exercise types with collaborative environment for teachers. The motivation to design a game mode into ViLLE was to increase students' engagement in doing the exercises. Our goal was to extend the existing system without compromising the learning effects that have been discovered earlier. The game mode was implemented so that the normal work flow of doing ViLLE-exercises is not disturbed. Instead of doing the exercise alone the students compete against other students. The students receive points similarly to normal mode, but in addition they can collect experience points, higher ranks and awards by succeeding in matches. The winner is based primarily on the score achieved, and only secondarily on the time used to emphasize the point of doing exercises properly.

Keywords: Programming education, learning environments, games based learning.

### I INTRODUCTION

Learning to program can be a frustrating task for novices. As stated in e.g. [1] and [2], students lack of motivation and the difficulty of the topics involved lead to high drop-out rates and poor learning results in the introductory programming courses. Hence, there are several new methods suggested to address these issues: Boyle [3] states that using new methods – and especially web-based environments – can lead to increased motivation and better learning results.

Online learning environments, especially when combined with automatic assessment and immediate feedback [4], can provide several potential benefits for both, students and teachers. The teacher can re-allocate teaching resources from exercise assessment to lecturing and personal guidance. The students can access the exercises from any location (and at any time), and usually re-take the exercises as many times as they want.

We have developed an online learning environment called ViLLE at the University of Turku. It contains several exercise types, all automatically assessed. The environment is used as an essential part of all of university's basic programming modules. However, it is likely, that the motivation to take the ViLLE exercises still remains external in many cases: the students complete the required amount of exercises, since completing those exercises is required to pass the course.

In this paper, we're presenting a game mode to increase students' motivation in using ViLLE. Instead of taking the exercises alone, the students can compete in any of the exercise types against other students. The emphasis still lies in learning; though the students competing are racing against time, the score obtained still primarily depends on the correctness of the answer.

The paper is structured as follows: first, related work, with focus on games and learning, is presented. Next, we introduce ViLLE and present previous studies of the system. In the following chapter, we discuss the motivation for developing a game mode, and introduce the game mode itself. Finally, conclusions and ideas for the future development are presented.

## 2 RELATED WORK

Susi et al. [5] state, that edutainment “refers to any kind of education that also entertains even though it is usually associated with video games with educational aims”. Games based learning (GBL) [6] is a form of edutainment, where (computer) games are used to engage users to learn a new set of specific skills. Serious games refer to games that are used for “training, advertising, simulation, or education” [5]. Prensky [7] states that games are an excellent opportunity to engage students into real learning. Though the concept of using games in education is quite well accepted, there are little examples in using serious games to teach programming. Connolly et al. [8] present examples of using games to improve engineering education, and continue to introduce a game based on that literature. Rajaravivarma [9] presents a game-based approach for teaching introductory programming course; however, the focus is on word and number games instead of games designed especially for teaching programming concepts.

## 3 VILLE

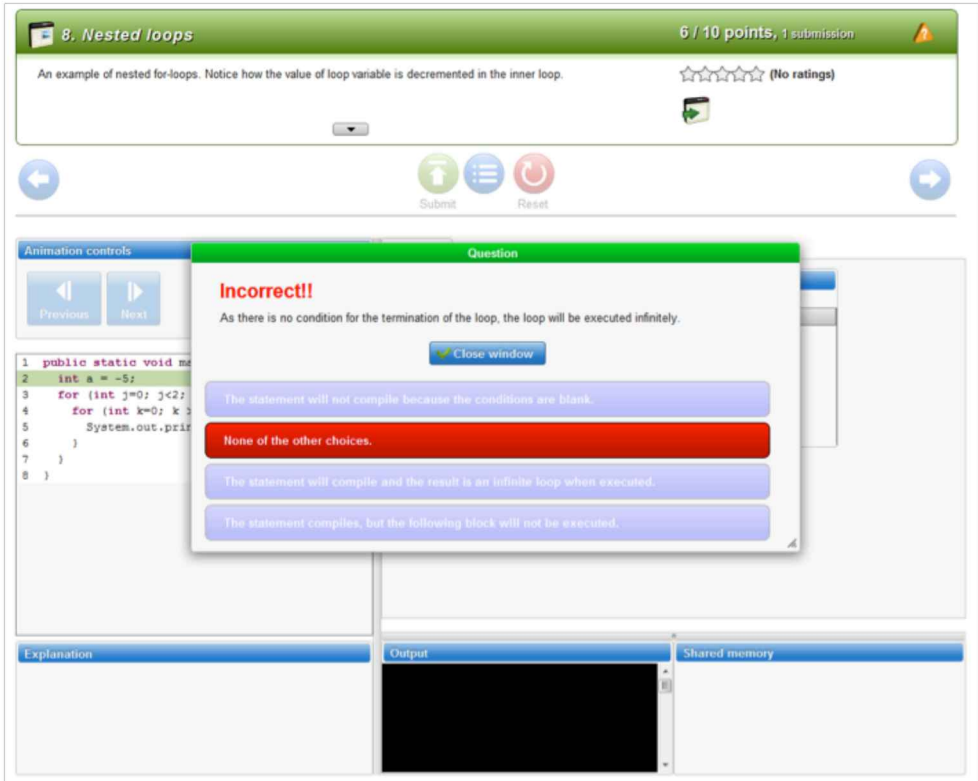
ViLLE is a collaborative learning environment, developed at University of Turku. It contains several exercise types, all automatically assessed. Despite providing course and exercise views for students, ViLLE acts as a “Facebook for teachers”, providing possibilities to browse, annotate, rate and utilize all public content created by other teachers. There are currently almost 5,000 students and more than 200 teachers registered into ViLLE. In this chapter, an overview of student and teacher views of ViLLE is described. Moreover, we present some earlier studies about the effectiveness of ViLLE. More information about ViLLE can be found at the tool website <http://ville.cs.utu.fi>.

### 3.1 Student view

There are several exercise types in ViLLE, including for example

- Visualization exercises: combine the graphical execution of the program code in selectable language with multiple choice and open questions. See Figure 1 for example.
- Code sorting exercises: an implementation of the Parsons puzzles [10], where the students need to sort the shuffled program code lines into correct order.
- Coding exercises: students need to write a program (or a part of it) to fulfill given requirements.
- Clouds & Boxes: turns the concept of visualization exercise upside-down: instead of

- tracing the visualization, the students need to visualize given program code step by step.
- General exercise types: besides programming exercises, there are several exercise types (e.g. quizzes, surveys, puzzles etc.) that are utilized in all kind of courses.



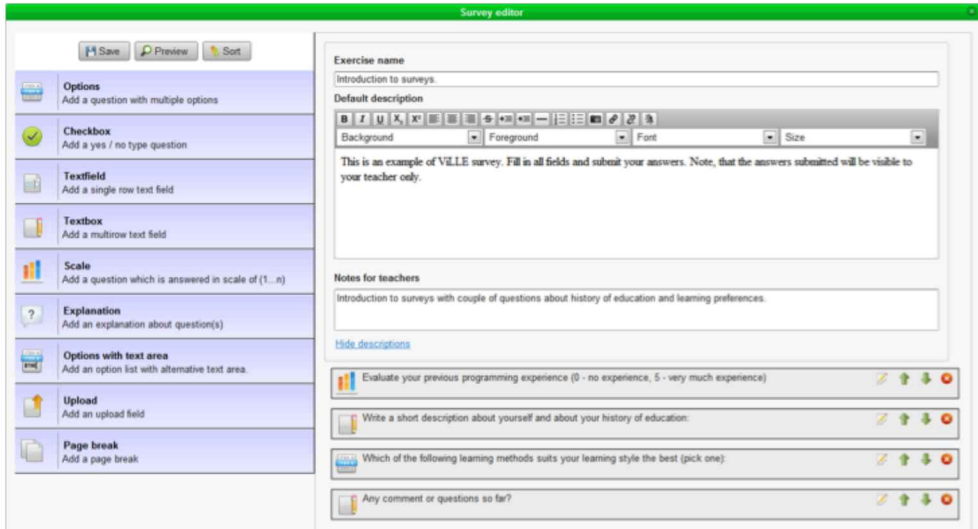
**FIGURE 1.** *The visualization view in ViLLE.*

ViLLE also supports a variety of programming languages, and provides an automatic translation between languages (though naturally only a selected subset of features is supported). ViLLE's math editor provides an easy way to write and display mathematics in web pages. Other important features include e.g. electronic exams, peer reviewed exercises and exercises constructed by students.

### 3.2 Teacher view

In teacher view, ViLLE provides versatile tools for handling courses, exercises and materials. Exercises can be created and edited using built-in editors (see Figure 2). Moreover, all content can be annotated, rated, commented and browsed based on any of these criteria. All public content can be immediately utilized in own teaching. Multifaceted statistics provide all essential information about students' actions in the course. Other important features include

e.g. manually graded assignments with support for assigning them to assistant teachers, research project management and a one-click course copy feature.



**FIGURE 2.** *The survey editor in ViLLE.*

### 3.3 Previous Studies

We have previously studied the effectiveness of ViLLE in various occasions: the effectiveness of ViLLE in learning results was studied in [11] and in [12]. We found out, that using the tool is highly beneficial for novice students, but only if used in higher levels of engagement. This supports the findings of Laakso [4]: automatic assessment and immediate feedback can be used to support the learning process substantially. We have also studied e.g. the collaborative use of the tool [13] and the effects on learning outcome when the tool is integrated into whole course [14]. More results can be found in [15]. The complete list of publications is available at ViLLE website at <http://ville.cs.utu.fi>.

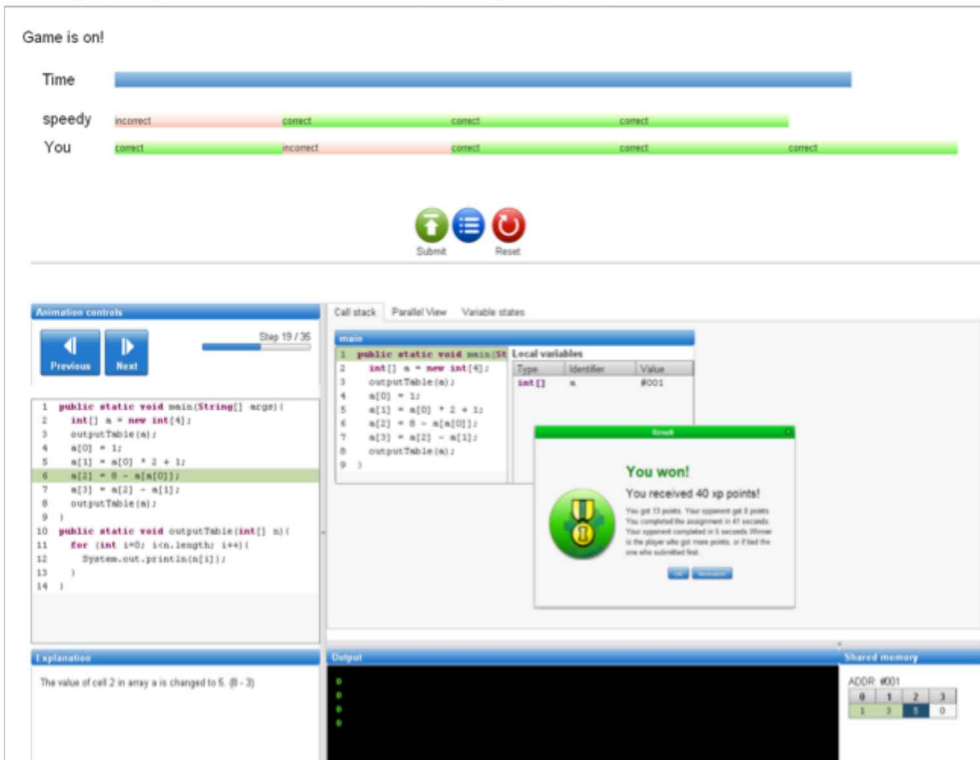
## 4 GAME MODE

Students using ViLLE have found it both beneficial and motivating to use [15]. However, it is likely, that further increasing students' motivation would result into larger submission numbers, and hence better learning results. To accomplish this, we have designed and implemented a ViLLE Game mode, where the students can compete in course's exercises against other students.

### 4.1 Game mode in ViLLE

The basic approach in development was that the game mode should be integrated tightly into ViLLE's existing student view. Hence, instead of creating a whole new view, the existing view was extended to contain a possibility of doing the exercises in the game mode. Students can

compete against other students in any of the exercise types (though currently some exercise type implementations for game mode are still incomplete). There are two factors considered when deciding the winner of the match: the first one, score obtained from the exercise, is the most influential. If the score is tied, the second factor, time used to complete the exercise, is used to decide the winner. The approach was chosen to encourage the students to still do the exercise as thoroughly as possible instead of rushing through to gain points.



**FIGURE 3.** The game mode in action. Current user has won the match.

The other important factor we decided to include was the interactive view to the match: since the students are taking the exercise at the same time, other students' actions are displayed at the top of the exercise view in real time. This means, that for example in visualization view, the student can see other student's progress (including time consumed, correct and incorrect answers etc.) as she answers the same questions. Game mode also contains a chat function, which can be used to change messages with the opponent. The game mode view is displayed in Figure 3.

The reward system for playing was also considered. The students gain two type of points when taking matches: first, they get "normal" ViLLE points, just like when they are taking the exercises in normal mode. This means, that it's possible to complete the whole course's worth of exercises in game mode. Second, an independent experience point system was developed:

the students get experience points by winning the matches. The idea is later to create top lists for best players in the round, course and in the whole system. As stated in [16], the students are likely to complete more exercises and spend more time taking them, if a reward – even an insignificant one – is given and if the list of best players is visible to all users.

#### 4.2 Online Mode

There are two modes for competing (though the mechanics are somewhat hidden from the students): in online mode a student competes against other students in real time. This means, that after logging into a course with game mode available, the student can challenge any of the other students currently online by picking up an opponent and an exercise. The online mode also features a chat, which can be used to message the opponent during the match. The online mode is not limited to the current course: the student is able to view a list of all students online attending any of the same courses.

#### 4.3 Offline Mode

Since it's likely, that especially in the smaller courses (and in the odd hours) there are not players online all the time, we created an offline mode as well. In offline mode the player competes against other student's previously submitted answers at the real time. In student's point of view the match looks almost identical: the progress of the other player can be traced at real time similarly to online mode. The only feature missing is naturally the chat function. In offline mode the player can also select the difficulty level: in more difficult levels the system picks a better submission to compete against than in the easier levels.

### 5 FUTUREWORK

There are clearly some things we need to consider and implement in future to further improve the game mode functionality. First, there are still some exercise types that are not supported in the game mode. However, some types probably need to be left out: for example, it might be difficult to evaluate which student answered a course ending survey better. Moreover, the top list functionality is still not implemented thoroughly: in addition to course's top players we are planning to include more comprehensive lists, such as "best players in ViLLE", "best players using Java" etc. Also, we are planning to include ranking and award systems to further enhance motivation.

Another crucial issue is the throughout testing of the game mode. For now, the initial testing has been done in rather small programming course, with approximately 10 students. There are two directions we want to take the future testing towards: first, the game mode should be tested in larger (100 or more students) courses before releasing it to all students. Second, a study with controlled setup should be organized to find out if the mode can actually benefit students compared to ViLLE's normal mode.

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