Wollok: language + IDE for a gentle and industry-aware introduction to OOP

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ABSTRACT

Students often have difficulties in learning how to program in an object-oriented style. Frequently, the programming tools used in initial courses are either too complex for the students at that stage, or simplified in such a way that makes the transition to industrial work environments hard. The languages used require them to understand a lot of abstract concepts, even for producing simple programs. These deficiencies can be perceived in later courses or even in professional practice.

In this paper we present the *Wollok IDE*, a novel educative development environment to teach object-oriented programming. *Wollok IDE* differs from existing teaching tools in that its features and design are conceived to support a carefully designed *incremental learning path*. that makes it easy to start with a minimal set of concepts and then smoothly transition to more complex models and tools, including in particular industrial ones.

We also enumerate the pedagogical motivations that guided the design of Wollok's main features, and how they support and enhance the learning process. We have evaluated this tool using it in around 30 teaching courses over 2 years including more than 1000 students. We show data of students interviews and surveys which reveals a higher ratio of approval and a deeper understanding of theoretical concepts.

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1 INTRODUCTION

Teaching how to program has revealed itself a difficult task [6, 23]. We have individualized three specific aspects present in many initial programming courses that hinder the learning process: (a) a complex programming language, (b) too many concepts needed for a first working program and (c) programming environment that are not conceived for the specific needs of an initial student [22]. While some of these problems are general to any initial programming course, our main focus are object-oriented programming (OOP) courses.

There have been proposals to tackle the first two problems by defining specific languages that provide simplified programming models [9, 11]. Our work is based on *Wollok* [20], an educative language designed to support a novel path to introduce OO concepts [1, 2, 15] This alternative learning path proposes to focus first on objects, messages an polymorphism, delaying the introduction of more abstract concepts, such as classes, types or inheritance (*cf.* Section 2).

Also, there are pedagogical approaches that focus on the programming environments. Some of them, propose to use industrial environments [3, 5, 18, 24], but beginners have specific needs that frequently are not adecquately addessed by industrial tools. On the other hand, there have been proposals of educative environments [4, 8, 10] that cover student needs but differ too much from their industrial counterparts, frequently making the transition difficult for students.

The main goal of this paper is to describe the *Wollok IDE*[1], a programming environment that supports a gentle introduction to OOP, as well as to escort the student in the path to more complex, industry-like programming models and tools.

By using an educative language frees the IDE from coping with advanced features (*e.g., reflection)* that are common in industrial OO languages, but not required in an introductory course. This, in turn, allows for more customized tools, *e.g.,* which can provide better feedback for some typical errors (*cf.* Section 4.2). Finally, the *Wollok IDE* integrates software engineering tools, such as unit testing or code versioning and sharing, that allow for a first introduction to these thechniques.

In Section 2 we present the problems of learning Object Oriented programming together with a brief introduction to our pedagogical approach. Section 3 describes the iterative methodology used for

[1] http://www.wollok.org/. Source code and documentation can be found in Github (https://github.com/uqbar-project/wollok). Wollok is open-source and distributed under LGPLv3 License (http://www.gnu.org/copyleft/lgpl.html).

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the development of our pedagogical approach and the tools that support it, while Section 4 describes some characteristics of these tools and their role for teaching programming skills. Section 5 compares our solution with another similar approaches, while Section 6 describes the results obtained. Section 7 analyses some key design decisions and Section 8 summarises our contributions along with some possible lines of further work.

2 WHY WOLLOK?

One cause behind the difficulties in learning OOP is the use of languages that require the student to understand a lot of abstract concepts before being able to produce the simplest program [13]. Figure 1 shows an example of a possible first program, written in Java [12]. Before being able to have a first object and send a message to it, the student has to deal with packages, classes, variable scopes, types, arrays, printing to standard output and class methods. Courses tend to spend too much time on the details of a specific language, leaving too little time to become fluent on the distinctive featuresof OOP, such as identifying objects and their knowledge *relationships*, assigning *responsibilities* and the power of *encapsulation* and *polymorphism* to build robust and extensible software.

Moreover, frequently the students do not have proper tools that could help them to overcome all the obstacles. This has even more importance if we want courses to deal with larger programs and to teach concepts such as testing, debugging and code reuse [13].

For example, writing to standard output would be considered a problem in industrial software construction and teaching the students to try out their programs in this way introduces a bad practice, which will have to be *unlearned* later. Still, some kind of user interaction is required in order to see the behaviour of the program, even if proper handling of it is beyond the scope of an initial OO course.

```
package examples;

public class Accumulator {
  private int total = 0;

  public int getCurrentTotal() { return total; }
  public void add(amount) { total += amount; }

  public static void main(String[] args) {
    Accumulator accum = new Accumulator();
    accum.add(2);
    accum.add(5);
    accum.add(8);
    System.out.println(accum.getCurrentTotal());
  }
}
```

Figure 1: Sample initial Java program which diverts student attention from the most important concepts.

Wollok provides an *simplified programming model* (SPM) that allows students to create programs containing objects, messages and polymorphism without the need for more abstract concepts such as inheritance, type annotations or even classes. Wollok also allows the incremental introduction of more abstract concepts, providing a smooth transition into a full-fledged OO programming model.

The example in Figure 2 shows a possible first program in a Wollok-based OO introductory course. Syntax has been reduced to a minimum and the basic constructs of the language match exactly the concepts we want to transmit, *e.g.,* var is used to define variables and method is used to define methods. The accumulator object is defined as a stand-alone (*i.e.,* it has no visible class) and *well-known* (*i.e.,* globally accesible) object (WKO).

```
object accumulator {
  var total = 0
  var evens = 0

  method getCurrentTotal() { return total }
  method add(amount) {
    total += amount
    if (amount % 2 == 0) { evens += 1 }
  }
  method evenCount() { return evens }
}
```

Figure 2: Sample initial Wollok object definition.

To allow the student to interact with objects while avoiding I/O a *read-eval-print-loop* (REPL) is provided. Shortly after in the course, we introduce unit testing, which slowly replaces the REPL as the main form of interacting with objects. These tools are described in detail in Sec. 4.4.

The presence of literals for lists (*e.g.,* [1,2,3]) and sets (*e.g.,* #{1,2,3}) allows us to use collections and, therefore, increase the complexity of examples that we can build before introducing classes. We also introduce *closures* at this stage.

Afterwards, we introduce classes. Wollok helps us in the transition: any pre-existent stand-alone object can be converted into a class by just changing the keyword object for class[2]. Moreover, stand-alone objects can be used in the same program and even be polymorphic with class-based objects. Examples of all these language features can be found in [20].

While neither the language itself nor the programming environment contain novel features that are unseen in industrial tools, the assemblage of selected features, each one carefully selected due to its educational value, is not found in other previous programming environments, neither educational nor industrial. Often, the rich set of tools an industrial IDE offers cannot be exploited by an inexperienced programmer. Even worst: they can cause confusion. Therefore, there is much to gain from a language and IDE that provide the exact tools a student can understand and take advantage of at each stage of his learning process.

At the same time, we have noticed that sometimes students have a hard time translating their knowledge to their professional activity. We think that a good mitigation tool ist to bring the activities in the course as close as possible to the professional practice [17]. We put special emphasis in solving the apparent contradition between customizing language and environment for student needs and at the same time keeping them close enough to their professional counterparts. At the same time, we incorporate industrial best practices such as code repositories and unit tests, adapting them to the possibilities of students with little or no programming experience.

The current study and development have been focused on university students which have had a previous subject on imperative programming. The natural extension of this work is the adaptation

[2]As a matter of fact, we will also change the name, as our code convention mandates lowercase names for objects and uppercase names for classes

of these ideas to teenagers or, more generally, students without any prior programming experience.

3 METHODOLOGY

Wollok language and IDE are developed in an iterative process, guided by our pedagogical approach and at the same time providing the basis for a classroom experience, which in turn provides feedback to the process.

After each university semester, both students and teachers are surveyed. Questionnaires are designed to determine which are the topics that result more difficult for students, and to analyse the relationship to other variables, such as the order in which concepts are presented, the practice and examples used in each stage of the course and the support tools that could help grasping each concept.

Then, the results of surveys is analyzed by a board of teachers from five universities. Although each teacher has his own way in front of the course, there is an extensive basis of agreement. This consensus allows us to create shared teaching supplies, such as theoretical material, sample exercises and exams and other support tools. In the last years, a big amount of this effort has been specifically devoted to define and build the Wollok language and IDE.

During 2017, 140 students answered the surveys, including also some courses that do not use Wollok. Most of them were surveyed twice: before and after the course, in order to follow the evolution of each student and to analyse the relationship between their previous experience and their perception of the tools. Surveys are anonymous to ensure that students are not afraid of posting negative critics[3].

The information gathered from surveys has been complemented by individual interviews. To anonymity, interviews are always conducted by a teacher of another university. Interviews were guided by the same questions as in the survey, but allowing for longer, open responses and giving the opportunity for the interviewer to deepen some topics, depending of the student answers and background.

Adding up these techniques allows us to gather different flavors of data, combining the statistically more significant data obtained from surveys and with the deeper insights that can be obtained in an interview. Also, interviews allows to discover oportunities for improving the questions in future surveys.

Finally, we collected retention and approval data, along with final exams, from courses using different approaches, languages and other tools. The results of this process are detailed in Sec. 6.

4 THE WOLLOK IDE

The *tools* used to write, analyse and evaluate the code have a paramount relevance for in the experience of the learning programmer and therefore for the success of the programming courses. Beginner programmers are expected to make more mistakes both simple (*e.g.,* syntax) and conceptual, as they are just in their way to comprehend the underlying theory. Therefore, the kind of support they needis different from that required by an experienced programmer.

We decided to embed the Wollok language in an integrated programming environment, whose features are designed having in mind the specific needs of novice programmers. We consider these tools to be a fundamental part of the pedagogical approach, pursuing the following goals: (a) to guide and ease the actual code writing, (b) to detect several of the most common mistakes done by novices, providing adequate feedback, and even to suggest corrections when possible, (c) to navigate and give different perspectives of the program, (d) to test and experiment with objects, both those created by the student and those provided by Wollok.

We remark that several of the tools that the Wollok environment provides are similar, yet customized, to those provided by mainstream industrial IDEs like Eclipse, Visual Studio or the Idea series. In this way, we aim to make both the programming experience more appealing to the students and the transition to later courses and work environments softer.

4.1 Basic guidance for writing code

The syntactic strictness of programming languages imposes a harsh barrier on novice programmers. Errors due to mispelled keywords or lack of proper delimiter match (*e.g.,* braces) are both frequent and frustrating for them[4]. The Wollok IDE code editor helps avoiding those problems by providing syntax highlighting, automatic insertion of closing delimiters, and the proposal of a proper indentation scheme. The latter feature also aims to improve readability of code, and also to induce good code organization practices.

The Wollok IDE also provides *content assist*, *i.e.,* in certain contexts, the IDE can autocomplete an identifier name, or provide a list of possible completions if there are many (*cf.* Fig. 3)[5].

At a bigger scale, Wollok admits the definition of several objects and/or classes in the same file. This allows for initial examples that use several objects and polymorphism without requiring the students to struggle with imports and packages. These concepts will arise later in the course, when students' programs increase their complexity to a level that demands for modularization.

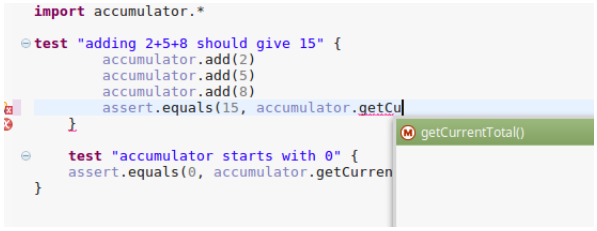

Figure 3: A list of suggestions from the Wollok IDE content assistance.

4.2 Detect mistakes and help fixing them

The Wollok IDE is able to detect statically several mistakes frequently made by students. Besides basic errors like syntax or references to undefined identifiers, the code analysis can detect several programming errors, *e.g.,* a method must return in all execution branches or in none, or abstract classes cannot be instantiated. Other, more subtle errors are indicated as warnings, such as unused or never-assigned variables. Also, the code analysis enforces selected programming practices, *e.g.,* class definitions must follow a definite order: instance variable declarations, followed by constructors, followed by methods.

[3] Students that answered both initial and final course surveys were asked to identify themselves using a nickname, allowing us to correlate their responses.

[4] Of course, block-based and visual programming tools make these problems just vanish, but such tools would not be adequate for the intended uses of Wollok.

[5] Currently this can autocomplete variables, constants and messages sent to self, super or any WKO. Current work in progress includes a *type inferer* that will allow to extend the content assistance capabilities to any context.

These errors are, detected while the student is typing a program and are shown *in place* in the editor. Error messages aim to explain mistakes in the same terms in which the teacher talks to students. In some situations, the IDE proposes possible *automatic fixes* to the detected problems. Figure 4 exemplifies this feature along with the rendering of a code error. The mispelled identifier is underlined and if we pass over the mouse on the error report, we get an error message together with possible fix. In this case, the automatic fix will insert an empty method in the adecquate position.

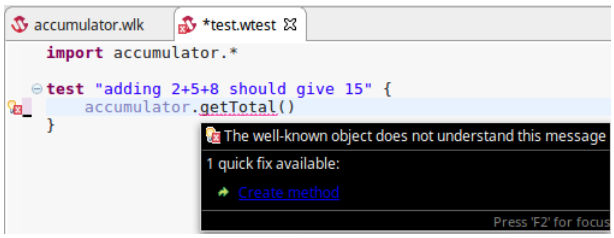

Figure 4: Example of a simple error detection.

By focusing on quick visualization and a proper understanding of their mistakes, we intend to empower students to explore different ideas, receiving constructive feedback. While this does not replace the more personalized feedback a teacher can provide, in several situations, a sensitive automatic feedback helps students not to stay stuck with simple errors waiting for assistance. This, in turn, allows for more agile lab classes and, therefore, for the possibility of including more exercises during a course.

Moreover, some simple topics that are not crucial for the course can be left for the student to learn by herself in the interaction with the IDE, instead of to being explained in class. This is specially useful for some errors that only some students are likely to make, *e.g.,* students with previous experience in OO languages but without a good theoretical support. We prefer to avoid covering these errors in class, because it would imply to show a bad solution to the rest of the students, who had otherwise not thought about it. While anticipating errors could be a fine strategy in an advanced course, it frequently confuses beginners. By having the IDE IDE detect the mistake and show possible solutions, we can tackle the problem only for the students that effectively incur in this kind of errors.

4.3 Coping with bigger programs

Code navigation and visualization tools can significantly improve the programming experience, both for students and practitioners. Lack of such tools frequently misleads students to avoid correct modularization of their program, as they feel more difficult to cope with a program that is divided in several small pieces. The Wollok IDE supports basic navigation tools, such as from a class reference to its definition, from a message send to the corresponding method (when such method can be determined) and back-and-forth navigation on code portions resembling that of Web browsers.

Some code visualization tools are available as well. An outline view and automatically generated static diagrams (*cf.* Fig. 5 right and left respectively) provide streamlined views of the classes and WKOs defined. Clicking a class, WKO or method pops up the corresponding definition in the code editor. These tools are useful to induce students to abstract themselves from the details of some portions of a program, understanding objects and classes as black boxes that provide some services, instead of attempting to have all of them in their head at all times.

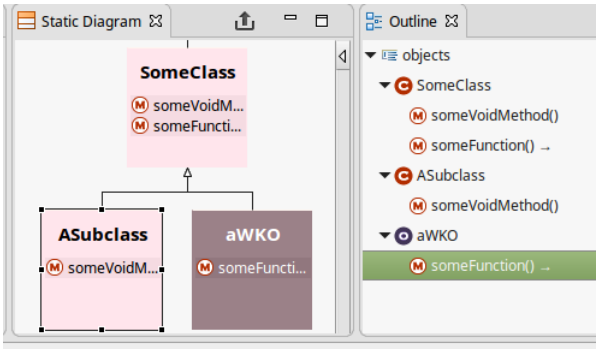

Figure 5: Static diagram and outline.

The Wollok IDE also includes some tools to help students to manage the whole set of code produced along a course. Source files are organized in *projects*, which have a predefined directory structure including both files for class/object definitions and tests. Together with the integrated *git* support, these features alleviate the frequent difficulties novice programmers find to organize their source files and to coordinate work in group assignments. This allows us to avoid the usual problems of version reconciliation that arise when improper techniques are used, such as sharing code in *zip files* sent by e-mail. At the same time, we are teching good development practices, that will be useful in professional practice.

4.4 Tests and experiments

As we described in Section 2, Wollok provides two ways of working with the defined objects and classes: the REPL and the definition of tests.

The REPL is first introduced and provides a simple environment for direct object manipulation. Running a program in the REPL brings all defined objects to life, allowing the student send messages to the them and see how they respond (*cf.* Fig. 6). In some courses, we even *start* on the REPL by sending messages to objects provided by the teacher. In this way, students get familiarized with the most important concepts of OOP: *object* and *message*, before going into the details about how these objects are implemented. The REPL also allows the programmer to define local variables, useful to remember intermediate results to be used in further operations, allowing for more complex object manipulations.

```
Wollok REPL Console
Wollok interactive console (type "quit" to quit):
>>> accumulator.add(2)
>>> accumulator.add(5)
>>> accumulator.add(8)
>>> accumulator.getCurrentTotal()
15
>>>
```

Figure 6: Sample usage of the accumulator in the REPL

As REPL interaction grows, students realize that they are doing repetitive operations there and start looking for automation. At this moment, *automatic tests* are introduced. Fig. 8 shows the test runner tool output for the test shown in Fig. 7.

```
import accumulator.*

test "adding 2+5+8 should give 15" {
  accumulator.add(2)
  accumulator.add(5)
  accumulator.add(8)
  assert.equals(15, accumulator.getCurrentTotal())
}

test "accumulator starts with 0" {
  assert.equals(0, accumulator.getCurrentTotal())
}
```

Figure 7: Sample test Wollok program.

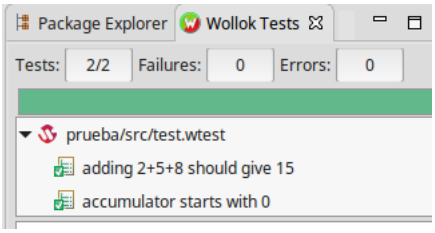

Figure 8: Test runner view after a sucessful test run.

The Wollok test runner simplifies unit test creation for for begginners by automatically providing *test isolation* [16], *i.e.,* global state is reset after each individual test case is run. For example, the messages sent to the accumulator in the first test in Figure 7 will not affect the state of the accumulator in the second test.

It is important to notice that the test requires a *higher level of abstraction* than the REPL. Now the student has to anticipate the result that some expression should yield, write both the expression and the expected result and interpretate a *green bar* as a signal that the answer was the expected, without ever seeing it.

5 RELATED WORKS

Several approaches have recognized the value of tools to support introductory programming courses, dating back to the creation of Smalltalk [7] and, later, Self [24]. These environments are undoubtedly powerful and many of the tools and ideas they introduced are still used today [3, 5], but they are too different from the main tools used today, which hampers one of our main goals. One of outstanding caracteristics of these environments to understand programs as a network of *live objects*. Live environment allow the programmer to manipulate objects or even modify their code while the program is running. This is a very powerful tools for a professional, but begginners can not take advantage of it because modifying code while its running requires a deep understanding of the nature of the code being changed.

Moreover, a view in which the program is represented by *code* makes it easier for begginners to reason about their programs. Other environments with similar views as ours, such as Loop [8], have difficulties to model unit tests, because of the interference between the live objects in a *live image* ant the requirement of unit tests to well-known initial state. Therefore, Wollok IDE is designed to bring as much as possible features from these tools into a file based environment.

Also, Traffic [18] and BlueJ [10] are educative environments that share several points of view with Wollok IDE. Both of them propose alternate paths for introduce the main concepts; BlueJ proposes an *objects first* approach and Traffic proposes an *inverted curriculum* with an *outside-in* strategy. Both recommend to teach about design and architecture and to embed programming tasks in a broader *software development* view, right from the first introductory course.

Still, both of them use industrial languages (Java and Eiffel, respectively) that require the students to handle several abstract concepts that are too complex for a begginner. In the case of Traffic, both the language as the IDE are meant for professionals and, in our view, too harsh for begginners. BlueJ proposes proposes a *Graphical User Interface* (GUI) to create objects. Similar approaches are followed by In our experience, this strategy can lead to difficulties in the posterior transition to full fledged IDEs.

Other environments make use of block-based or visual programming, such as Scratch [4], Etoys [14] and Kodu [21]. In our vision, these tools are suitable for stimulating interest in programming and for being used in secondary education, but not beyond that stage.

6 RESULTS

Since March 2015 Wollok has been used to teach introductory OOP courses in more than 30 courses in five different universities, reaching almost 1000 students. It has also been used at highschool level. Some of these ideas where also present in other tools we had previously developed, going back to 2006. In these 12 years, our approach, although evolving, has been applied by more than 100 teachers and 6000 students. In several cases, approval rates changed from 30–40% to 80–90%.

At the same time, the level of the courses has been consistently increased, covering more topics and requiring the students to build bigger programs with higher design quality. As a way to measure the knowledge level, we analysed the difficulty in final exams. Frequently, the programs required to pass a final exam used to consist of only one or two classes, with no more than 6–8 methods, and only one (fairly simple) usage of polymorphism. Current exams require the student to write a program with 10–15 classes and no less than 20 methods (excluding getters and setters); there are more usages of polymorphism and often they require to come up with some non-obvious abstractions. Metrics from 2017 show that 88% of the students that started the course took the final exam, 96% of those where able to complete the required program (and tests) in less than four hours. The final approuval rate was 79%.

For a better understanding to the effect of using Wollok, we have realized surveys and interviews, organized according to the ideas described in Section 3. We surveyed 15 courses, obtaining 133 responses. These surveys show that 84% of students found Wollok significantly easier to understand than other languages (*cf.* Fig. 9), and 95% thinks that Wollok has helped them understand their mistakes and learn from them. At the same time 70% of the students consider that having learnt Wollok will help them in their professional practice. This was confirmed in interviews, which showed that the subject provides a solid theoretical base; the students are aware of the new theory they incorporated and they are capable of applying these concepts in different technologies and situations.

Interviews also confirm that students have no problems recognizing the applicability of the concepts learned, *e.g.,* several students with professional experience affirmed that learning OOP with Wollok led them to improve their professional practice. Others indicated

	Abs.	Sign.	Part.	Not	N/A
Easier to learn than other languages.	33	74	16	4	4
Helps understanding errors	47	78	5	1	0
Similar to previously known languages.	19	44	31	15	22
Helps professional activity	26	52	18	15	19

Figure 9: Student evaluation of Wollok Language and IDE. For each question, each student had to select between "Absolutely", "Significantly", "Partially" or "Not at all".

that having learned OOP with Wollok was of significant help to learn other modern OOP languages, such as *Swift*.

Students assign great value to the tools of the IDE. Some of the most appreciated tools are those that help understanding and visualization, such as outline, diagrams and class catalog. Another valued characteristic is the error reporting mechanism; most students mentioned it as a great help for debugging their programs. Finally, also integrated tooling is considered valuable, such as testing facilities and git integration.

On the downside, we discovered that students sometimes have difficulties finding some of the features of the IDE. We consider that this problem can be alleviated by both improving student documentation and building better teacher guidelines.

Also, they criticized that the IDE can be confusing because of having too many tools they do not know how to use. This is a known issue, due to an implementation trade-off: we intend to build a minimalistic IDE in which each tool is precisely selected according to student needs, but it would require a significantly bigger amount of work than current, Eclipse-based implementation. Even so, Eclipse is a customizable platform and the depuration of the IDE to remove superflous tools is a work in progress.

Other critics asked for improvements in error messages, autocompletion and smart suggestions, which shows that the students perceive the added value of this kind of tools.

7 TO IDE OR NOT TO IDE

A frequent controversy between software programmers is about the convenience of using an IDE or a simpler text editor for writing code. In the last decade, several languages, frameworks and other tools have become popular for which there are fewer visual or integrated environments.

This scarcity of tools has diverse roots. In some cases, the lack of type information undermines the possibility to implement features such as code completion, automatic refactorings or code navigation. In other cases, languages and frameworks change so fast that tools can not catch up. Frequently, there is also a matter of taste. Also, some teachers argue that providing the student with too many tools will make him dependent on those tools.

In our view, tools that simplify day to day work can not be neglected. We found that professional progammers use many tools that help them program consistently and efficiently. Many popular text editors allow for additions in the form of *plugins*, where the programmer can create his own personalized development environment. Other tools that are not integrated into the development environment, are inserted into the development process by other means; *e.g.,* a continuous integration process may run a *linter* on each commit, check the build and run tests. So, instead of a discussion about whether we need powerful tools, we rather see an evolution from heavy monolithic environments onto an ecosystem of light tools that allow the developer or team to create a unique environment which accomodates to their specific needs and taste.

Still, in our specific case, we opted for an *integrated* environment because it simplifies the set up for beginners. In more advanced courses, we think that it could be a good idea to let the students build their own environments.

8 CONCLUSION

The Wollok language and IDE have been put into practice for already two years, targeting hundreds of students. They have been successful in supporting an incremental learning path, allowing the users to train their OO modelling skills and providing a smooth transition to industrial languages and tools.

The IDE allows students to program in a controlled environment which helps them to avoid getting stuck, frequently guiding them to use the best programming practices. Also, it provides a controlled environment which empowers students to use their intuition, test their ideas and explore new possibilities. The combination of REPL and tests, we have succeeded in completely avoiding the need for I/O or undesired debugging practices, such as the inclusion of println expressions along the code.

By providing simplified versions of several industry-like tools, the Wollok IDE allows to introduce professional development practices early on in the curricula, helping the students in getting familiarized with the kind of practices and environment they find both in later subjects as in their professional jobs.

The main focuses of attention for the Wollok IDE development team are the detection of programming errors and bad practices, and the provision of quick fixes, content assistance and refactorings. A cornerstone to achieve these goals is the type inferer, which is one of our current main objectives. Still, providing a type inferer for a language such as Wollok has many subtleties, which deserve an independent study [19].

Other future tasks include extending the REPL to be a full-fledged editor which re-evaluates expressions after a code change, displaying the new results (such as Scala Worksheets[6]); improving team work support, and a web-based version of the interpreter.

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REFERENCES

[1] C.Lombardi and N.Passerini. Alumnos, docentes y recorridos en una materia de programación informática. UNQ – Argentina, Oct. 2008.
[2] C.Lombardi, N.Passerini, and L.Cesario. Instances and classes in the introduction of object oriented programming. DC - FCEN - UBA, Buenos Aires, Argentina, Dec. 2007.
[3] D.Ingalls, T.Kaehler, J.Maloney, S.Wallace, and A.Kay. Back to the future: The story of squeak, a practical smalltalk written in itself. *SIGPLAN Not.*, 32(10):318–326, Oct. 1997.
[4] D.Malan and H.Leitner. Scratch for budding computer scientists. *SIGCSE Bull.*, 39(1):223–227, Mar. 2007.
[5] S. Ducasse. *Squeak: Learn programming with robots*. Apress, 2006.
[6] E.Dijkstra. On the cruelty of really teaching computer science. *Communications of The ACM*, 1989.

[6] https://github.com/scala-ide/scala-worksheet

[7] A. Goldberg. *Smalltalk 80: the Interactive Programming Environment*. Addison Wesley, Reading, Mass., 1984.
[8] C. Griggio, G. Leiva, G. Polito, G. Decuzzi, and N. Passerini. A programming environment supporting a prototype-based introduction to OOP. In *Proceedings of the Intl. Workshop on Smalltalk Technologies*, IWST '11, pages 5:1–5:5, New York, NY, USA, 2011. ACM.
[9] A. Harrison Pierce. Mama-an educational 3d programming language.
[10] J.Bennedsen and C.Schulte. BlueJ visual debugger for learning the execution of object-oriented programs? *Trans. Comput. Educ.*, 10(2):8:1–8:22, June 2010.
[11] J.Bergin, J.Roberts, R.Pattis, and M.Stehlik. *Karel++: A Gentle Introduction to the Art of Object-Oriented Programming*. John Wiley & Sons, Inc., New York, NY, USA, 1st edition, 1996.
[12] K.Arnold, J.Gosling, and D.Holmes. *The Java programming language*, volume 2. Addison-wesley Reading, 1996.
[13] M. Kölling. The problem of teaching object-oriented programming, part i: Languages. *JOOP*, 11(8):8–15, 1999.
[14] Y.-J. Lee. Empowering teachers to create educational software: A constructivist approach utilizing etoys, pair programming and cognitive apprenticeship. *Comput. Educ.*, 56(2):527–538, Feb. 2011.
[15] L.Spigariol and N.Passerini. Enseñando a programar en la orientación a objetos. UTN FRC, Córdoba, Argentina, Nov. 2013.
[16] R. C. Martin. *Clean Code: A Handbook of Agile Software Craftsmanship*. Prentice Hall, 2008.
[17] R. McDermott, M. Zarb, M. Daniels, and V. Isomöttönen. First year computing students' perceptions of authenticity in assessment. In *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education*, ITiCSE '17, pages 10–15, New York, NY, USA, 2017. ACM.
[18] B. Meyer. The outside-in method of teaching introductory programming. In M.Broy and A.Zamulin, editors, *Perspectives of System Informatics*, volume 2890 of *Lecture Notes in Computer Science*, pages 66–78. Springer Berlin Heidelberg, 2003.
[19] N.Passerini, P.Tesone, and S.Ducasse. An extensible constraint-based type inference algorithm for object-oriented dynamic languages supporting blocks and generic types. Cambridge, England, Aug. 2014.
[20] N. Passerini, C. Lombardi, J. Fernandes, P. Tesone, and F. Dodino. Wollok: Language + ide for a gentle and industry-aware introduction to oop. In *2017 Twelfth Latin American Conference on Learning Technologies (LACLO)*, pages 1–4, Oct 2017.
[21] M. Research. Kodu.
[22] M. T. Singh. How to teach programming languages to novice student and problems in learning of students. *Journal of Computing Technologies (JCT)*, 1(2):5, 2012.
[23] T.Jenkins. On the difficulty of learning to program. In *Proceedings of the 3rd Annual Conference of the LTSN Centre for Information and Computer Sciences*, volume 4, pages 53–58. Citeseer, 2002.
[24] D. Ungar and R. B. Smith. Self: The power of simplicity. In *Proceedings OOPSLA '87, ACM SIGPLAN Notices*, volume 22, pages 227–242, Dec. 1987.