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Challenges in teaching computer programming

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Challenges in teaching computer programming

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Challenges in teaching computer programming

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It is generally held that computer programming is one of the most difficult courses in computer science programs both in teaching and learning. It is estimated that 33% of students pursuing computer science studies at universities and colleges around the world in 1999 either dropped out of or failed their first programming courses.

Technology is what is seen as the most significant driving force of development, and programmers are the main players in the advancement of technology. It is therefore an undeniable fact that the teaching and learning of computer programming should be given necessary attention.

In addressing the issue above, this thesis focuses on finding solutions to the teaching and learning of computer programming through e-learning by using the Viope educational tool as a case study.

The objective of the thesis was to assess the Viope educational tool (Viope World) in different cultural environments against well-known e-learning challenges to develop it further by giving suggestions on how to improve it.

Key words Programming, E-learning, Teaching

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1 Introduction

This thesis addresses the issues involved in the teaching and learning of computer programming. The work has been done in relation to Viope Solutions Ltd as the case study company.

This research focuses on the question of how useful the Viope online programming learning environment is in teaching and learning programming. Information has been gathered on Viope's cloud-based programming learning environment from both existing customers and prospective customers from different educational institutions in Europe and Africa.

Two students Kwame Afreh and Shan Wu have carried out this thesis work. Kwame Afreh is a Ghanaian international student at Laurea University of Applied Sciences while Shan Wu is a Chinese international student at the same university. Both of them pursued Business Information Technology. During their studies both have used couple of e-learning platforms. They also happened to have done their practical training at the same company Viope solutions.

Base on their experience in using e-learning tools as students, observation at the work place and closer look at the Viope educational platform, coupled with the company's intention to release a new version of the platform, they decided to find out the challenges in teaching programming and find the best solutions as possible which could be added to the new versions of the platform.

The empirical studies of this thesis has been done by Kwame Afreh through face-to-face presentations in 13 universities in Africa (Ghana & Nigeria), twenty (20) Online presentation in four (4) European countries and analysing testimonials from Viope educational tool existing users.

The theoretical part of this thesis has also been done my Shan Wu through desk analysis and bench marking. In spite of the divisions every decision was taken together as team working on this thesis.

1.1 Objectives

The purpose of this thesis is to assess the Viope educational tool (Viope World) in different cultural environments against the well-known eLearning challenges to develop it further by giving suggestions on how to improve it.

In order to improve the development of this tool, suggestions have been collected from long-time users and programming instructors.

The Viope cloud-based programming-learning environment as a programming tool was presented in 13 universities in Africa, 7 out of the 13 in Ghana and the other six (6) in Nigeria. A demo account of the tool was also sent out to several countries, including China and India.

The purpose of the presentation was to seek the views and questions of instructors on the tool and how those views and questions were addressing the challenges in teaching and learning programming to novice programmers.

Another reason for the presentation was to see how the tool can fit well in institutions, which are used to a traditional way of teaching and how they would embrace a new pedagogical tool like the Viope educational tool.

During those presentations the instructors with the intention to know how the tool will address them raised several questions. Those questions will be discussed later in this thesis under topics such as assessment, content management, connectivity, usability and simplicity of the tool among others.

A number of e-learning scientific papers were collected and analysis to figure out the challenges that researchers are more concerned about in the teaching and learning of programming. The emphasis was on challenges that were related to the teaching of the course and the methodology aspect.

The following e-learning tools Trakla 2, Webwork, Code lad, coding bat were also analysed and compared with the challenges. They were selected out of 21 e-learning tools for teaching and the researchers based on certain criteria reviewed these programming learning environment. This will be dealt with in a later section of this thesis.

1.2 Statements of the problems

Technology has been growing faster for the past 2 decades. It is an undeniable fact that programming plays the central role when it comes to technology. Computer programming is an integral part of a computer science curriculum and a major stumbling block for many students, particularly in the first year of study, (Miliszewska, Venables & Tran 2008)

Bennedsen and Caspersen, it is estimated that 33% of student pursuing computer science studies at the universities and colleges around the world from 1999 either dropped or failed their first programming courses. That is to say about 650,000 out of 2million plus students.). This is enough evidence to assume that there are problems involved in the teaching and learning of programming.

Other research in the same field has shown that it takes almost 10 years to change novice programmers into expert programmers (Winslow 1996). Programming also seems to be the major course in many computer science programs in institutions. This means that, if this problem of students dropout persist it is obvious students in future will be afraid of taking computer science programs.

“Teaching of initial programming is a significant pedagogical problem for computing departments. It is shown that by understanding the changing characteristics of computing student’s helps to identify their learning approaches and requirements. These findings are used to explain the rationale for the development and use of a virtual learning environment to support the learning of introductory programming” (Allison, Orton & Powell 2002).

Again Allison, Orton and Powell (2002) admitted that it is not only the learning of programming that is difficult but also teaching is not easy. To (Allison, Orton & Powell 2002) traditional methods of teaching do not conform or give enough support to coding and problem solving.

Programming is a skill that can be mastered or comprehended through experience. Students does needs a lot of practice to understand the concepts in programming but this is also difficult for instructor to use traditional method of teaching to achieve this since assessing students tasks manually takes time. This means that, e-learning tools have a role to play for novice programmers to be successful. But the question is which e-learning tool should be selected since they are in abundance.

It is obvious; the one that will address the teaching and learning of programming problems is preferable. This thesis seeks to examine one of such tools developed my Viope Solutions Ltd in Finland. As declared earlier, a lot of information has been obtained from some lecturers in Europe who have been using the tool for a number of years.

The tool was also presented in a couple of universities in Africa, to be precise Ghana and Nigeria. The idea was to see how the same tool would positively impact on the

teaching and learning of programming from different cultures as well as different mode of teaching. In this thesis, the Viope World will be depth into details. A few of other programming platforms were also analysed and have been mentioned here as well.

Some research papers suggest that, students' lack of motivation, self-efficacy, and failure to see the relevance of programming courses also influence success and failure rates (Rountree, Rountree, & Robins 2002) and (Wiedenbeck 2005). This work also seeks solutions to the problems pointed out by lecturers and researchers that hinder the progress of novice programmers.

Researchers in the teaching and learning of programming have listed numerous problems. Many researches have gone into this area but most of them seem to point out the problems without solutions. The few papers that try to provide solutions do so by mentioning or suggesting teaching methods without clear-cut solutions. For instance, some papers suggest computer software or e-learning tool for teaching programming without specifying what features the tool should possess.

In view of these issues, this thesis work seeks to look into the useful features such learning platforms should possess.

2 Methodology

Methodology plays a major row in the success of every research or thesis work. In fact the method one use determines the outcome of the thesis. In view of this there was the need to pick all possible methods that could ensure the success of achieving the objective of this thesis. Below are descriptions of the selected methodologies.

2.1 Presentation

Presentation and feedback were the main method used in this thesis. The researchers presented the Viope educational tool in both Europe and Africa mainly for the purpose of getting feedback on the tool as well as how the tool is seen in different cultures.

As specified earlier on, Viope educational tool was presented in 13 institutions in Africa, Ghana and Nigeria to be specific, 2 out of 13 institutions had test trial of 3 months each.

Feedbacks were collected right after each presentation regarding how they see the tool in teaching and what needs to be improved. The researchers had 3 months stay in Afri-

ca training potential users and collecting feedback during the 3 months trial test by the institutions.

Again, twenty (20) programming instructors were also presented with the tool for feedback and how to improve it. These programming instructors are from institutions in the following countries: Belgium, Sweden, Denmark and Ireland. At any point in the presentation, probing questions were used to seek instructors' views on specific features and ways of improving them if possible.

All feedback collected regarding how to improve Viope educational tool has been discussed under the recommendation. (See Appendices for presentation images and Video links)

2.2 Testimonials

Lecturers who have been using the Viope cloud-based programming learning environment gave their testimonials. Details of their response will be discussed later in this thesis.

As part of finding solutions to the above raised objectives, testimonials were one aspect of the method used in this thesis.

Four instructors who have been used Viope educational tools for years gave testimonials of their experiences. The perimeters of the questions were in the area of assessment, content management, connectivity, usability, simplicity and features. Our main objective of analysing their testimonials was to find out what kind of features/improvements instructors wish to have in the tool.

2.3 Desk Analyses

As a way of addressing the problem of this thesis, numerous research papers has been gathered in this field to ascertain the challenges in teaching and learning computer programming.

2.4 Bench Marking

In order to have a balance and general views of what instructors and students expect from programming e-learning platforms, 21 computer programming e-learning plat-

forms were also reviewed. The parameters for review were centred on features, users' feedback found by way of scientific paper written about the tool and demo assessment.

2.5 Observations

As users of e-learning platforms and observing how various instructors have been using and asking questions on e-learning platforms, it was necessary to add such observations in order to realize the best way of assessing and improving Viope educational tool.

3 Theoretical Background

A lot of papers are available in this field of research for instance "Improving Progression and Satisfaction Rates of Novice Computer Programming Students through ACME - Analogy, Collaboration, Mentoring and Electronic Support" (Miliszewska, Venables & Tan 2008) from Victoria University, Australia was a research for developing and implementing a strategy to improve the learning output of novice programming students at the university.

Notwithstanding, most papers or research seems to be dwelling much on why the novice fail or drop out. That is to say, those papers dwell much on the behaviour (characteristics) of the novice as the cause of their inability to excel in introductory programming.

It appears most scientific research papers on problems in the teaching and learning of programming put the greater part of the problems on novice programmers. This paper's aim is to review the specific problems in teaching and learning of the programming languages itself.

3.1 E-learning

3.1.1 Definition

According to Peter Goodyear, "e-Learning is the systematic use of networked multimedia computer technologies to empower learners, improve learning, and connect learners to people and resources supportive of their needs".

E-learning is the transferring skills and knowledge through computer or network, which enables people to learn anytime and anywhere. With the increasing important role

computer technologies play in our future life, eLearning becomes a significant way to support daily teaching and learning. Contents transfer through the Internet, intranet/extranet, audio or videotape, satellite TV, and CD-ROM and the form of contents can be categorized into five: documentation, image, animation, streaming video and audio.

Rise of the e-learning mode enable the possibility of distance learning, self-learning and other up-and-coming ways of learning, which cannot be achievable in classic learning mode. E-learning provides a great quality of benefits, such as affordability, time saving, and offering measurable results.

The most obvious benefit of e-learning is that e-learning frees users (both students and instructors) from traditional learning with fixed time and places. With more flexibility, e-learning offers opportunities of getting 24/7 studying. Instructors give accurate supports to students who need help but not spend time on giving lecture to the whole class or correcting homework. Furthermore, e-learning provides different types of learning that attracts students much more than traditional learning.

However the basic core of e-learning is not technologies as public acknowledge but learning. All the high-tech equipment is just instruments for supporting students to gain knowledge. E-learning requires users to have highly self-discipline and huge motivation.

3.1.2 Trends in E-learning

E-learning is developing in two major parts: technologies and ways of using. (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

E-learning achieves its goal with the help of developing technologies, and will be improved as time goes by. The progress of information technology is the primary support in e-learning updating and spreading. The latest trends in e-learning technologies are listed as follows:

Mobile technology:

Mobile phones and PDAs are the future platform for e-learning users, and then, digital pen and paper. Mobile technologies are more suitable than personal computer in providing unlimited space and time in studying because of the shape and size. With the extensive cover of 3G Internet, mobile technology can reach the same result but more

portable than PC while users are on a journey or moving. (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

Simulations in e-learning process:

Now, simulations are already used in e-learning to achieve the teaching goal and gain benefit by simulating the real teaching. Still, there is gap to fill between e-learning and real teaching. "Simulations may offer advantages over handbooks and they can complement lectures, demonstrations and real world practice opportunities." (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

Adaptive learning environments (ALEs):

Adaptive learning environment, according to the article, is explained by 4 definitions: monitoring users' behaviour, analyse the behaviour in the domain based model, offer with users' preferences and requirements by available knowledge, and combine these with learning solutions. (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

Open source e-learning tools:

Based on the following advantages; cost saving, stability, performance and access to code, open-source e-learning tools are new trend in e-learning technologies. Resources are offered and shared among users and updated promptly. (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

Standards development

"Standard development is meant to knit together disparate groups and interests in the distributed learning community" said by the author and six requirements are mentioned for judgments: accessibility, adaptability, affordability, durability, interoperability and reusability. (Carabaneau, Trandafir & Mierlus-Mazilu 2006)

Athey (2012) also mentioned Mobile Application and three other trends are as follows:

Gamification:

Does not mean make e-learning a real game but bring game-like characteristics to encourage the innate desire to compete and win during learning. Receiving rewards or showcase achievements like leaderboards are the excellent example of gamification.

Training developers can always change the gaming techniques to suit their topic or courses. (Athey 2012)

Social Collaboration:

“In 2012, if you do not have a social learning strategy, you will fall behind” (Bersin 2012). Social collaboration makes it easy to enter into knowledge from different levels or organizations and combine learners with lecturers closer with the flow of communication and information. (Athey 2012)

Bite-Size e-learning:

This separates the course into small sections, encourages users to learn during a break or in short spurts of time and achieves the goal of gaining knowledge step by step. The convenience of bite-size in mobile provides a chance for quick access to important materials and information. (Athey 2012)

3.1.3 Effects of E-learning on Educations

E-learning exists as an effective learning method bringing countless benefits to its users and providers. According to the article, “Positive Effects of e-Learning and Blended ITIL Training Strategies”, the major positive effects of e-Learning can be listed as follows.

E-learning is more cost saving than traditional learning. Low costs make benefits for more students. Aside the lower cost of e-Learning itself, it also reduces the budget of teaching space and teaching sources.

E learning frees students and users from fixed learning space such as school or classroom. Users of e-learning products can study wherever they want with computer and Internet. Also, it frees users from fixed time. Therefore, users can arrange their studying plan based on their own situations.

E-learning products offer systematically material and course delivery, so users can follow the same guidance and material that used the same products. This avoids discrepancies brought by different materials.

E learning saves time for both students and lecturers. It frees lecturers from setting and checking homework with the help of automatic checking system and exercise bank.

E-learning methodology meets the requirements of users in all organizations at the same time.

3.1.4 Setback in E-learning on Education

Although e-learning provides its users with a large number of ignored advantages, disadvantages still exist during learning. According to the article "Blended Learning: Overcome The Weaknesses Of E-learning And Traditional Approach", four obvious weaknesses have been summarized when comparing with traditional learning.

For most e-learning users, it is an individual behaviour that learning with the help of e-learning tools, therefore social interaction plays a less important role in it. Compare with student using traditional method of studying, e learning require a highly demand of effectiveness and self-discipline.

Even though e-learning can offer convenient study without the traditional learning source such as teachers, classrooms or books, it still requires basic skills and materials to set up. A personal computer and Internet skills keeps e-learning methodology away from some students due to lack of skills and lack of basic tools.

Explanation and clarification is clearer in traditional learning. Facial expression and gesture can help in illustration while e-learning communication can hardly achieve. Even in videophone, receiving party cannot react by subtle movements from people comparing with face to face communicate. (Hameed et al. 2008)

It is difficult to engage some students in productive and meaningful work in e-learning environment. (Jones et al. 2000)

4 Case Company

4.1 Profile

Viope Solution Ltd is a software company that specialises in e-learning, in the area of computer programming. Viope Solution was established in 2001 in Finland with the headquarters situated in the capital of Finland-Helsinki. Viope tool is the name of the software. The tool is web-based, which means that users need not install anything in order to use being it hardware or software for that matter. All that is required is Internet, and a browser to work.

4.2 Structure and Internationalization

Even though, Viope has been operating for the past ten years, because of the nature of the business, Viope still has a straightforward structure, as can be seen from the figure below. Internationalization wise, the company has been operating in Finland for the past 10 years. During the last two years, the company has been operating in Estonia, Holland, Denmark and Austria, making the number of countries of operation five (5). The figure below illustrates the structure of the company.

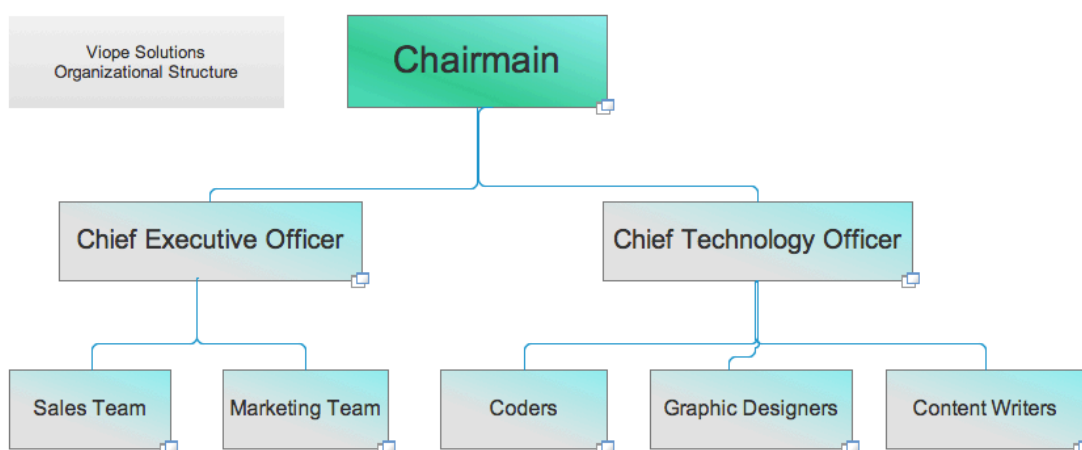


Figure 1: Viope Solutions-Company Structure

4.3 Operations

The Viope business model is based on co-operative networking. That is, their main source of growth is based on having long-term cooperation network with operators like Lappeenranta University of Technology, Laurea, Metropolia, Oulu University, Decanet, content writers and many more.

4.4 Products and Services (Viope World)

Viope main products are the Viope World (educational tool), Viope programming courses, Viope Recruit and also have services such World Game development contest. For the benefit of this thesis, the focus will be on the platform Viope World.

4.4.1 Viope Educational tool (Viope World)

Viope world is an integrated development environment for many programming languages including; C, C++, C#, Java, SQL and Relational Database, PHP, Ruby and Python. Viope World is a cloud-based platform. The platform has two main interfaces;

- Student Menu
- Instructor Menu

To use Viope world, both students and instructors require a license account to identify themselves in the form of ID and password to work in the environment.

Viope World has self-learning content, automatic response technology (ART) and Artificial Intelligence (AI). Viope world can be used for Self-studying, Blended-learning, and automated assessment.

The tool has multifaceted exercises as well as statistical features to help teachers in controlling teaching and observing student's progress respectively. Based on observation and actual usage, the tool in question offer possibilities for teachers to edit and execute examples to theory materials, examine exercises completed by a single student or a group of students, organize a virtual class, create exams without limitations and use ready-to-use exercises or his/her own exercises and organize remote teaching for one or several students.

The Viope Automatic Response Technology (ART)/Artificial Intelligence (AI)

The ART gives immediate feedback on student exercises thus directing and boosting the confidence levels of students especially in the programming exercises. The ART detects errors in student's codes and highlight it and gives students optional clues in correcting the errors. The ART saves the instructor's time of having to run student codes or spending a lot of time guiding them. All of that is being taken care of by the tool, so the instructor has ample time to see to the special needs of individual students.

The ART makes the platform exceptionally easy for instructors to conduct large student classes. For instance, an Associate professor of LUT who has been using Viope said in an testimonial video 2012 "As a teacher, I can have 200 students. So it is impossible to teach such amount of exercise which Viope is offering to 200 students individually. So when they learn they do it by themselves, I only assist on the network".

Handling of Files

Viope World support inputs and output of multiple files but the code itself consist of one file. A pure example of this case is shown below;

The screenshot shows the Viope World interface for a programming exercise. The exercise is titled "Handling files" and is part of "INTRODUCTION TO C PROGRAMMING". The task description states: "The files 'mata.txt' and 'matb.txt' contain integer matrices of size 10 x 10. Write a program that calculates the sum of the matrices in a new matrix. The resulting sum matrix shall be saved to the file 'sum.usr'". A red circle highlights the input files 'mata.txt' and 'matb.txt', and a red arrow points to the output file 'sum.usr' with the text "Two files given in the task and the code will give the third file". The example output shows: "The sum of the matrices has been calculated into the file sum.usr.". Below this is a code editor with C code for calculating the sum of two matrices and saving the result to a file.

```

44 }
45 for(i=0;i<10;i++)
46 {
47     for(j=0;j<10;j++)
48     {
49         if(j == 9)
50         {
51             fprintf(write,"&d\n",mata[i][j]+matb[i][j]);
52         }
53         else
54         {
55             fprintf(write,"%d ",mata[i][j]+matb[i][j]);
56         }
57     }
58 }
59 fclose(write);
60
61 printf("The sum of the matrices has been calculated into the file %s.\n",sum);
62
63 return 0;
64
65 }

```

Figure 2: Viope World-Two files given in one task

Viope Monitoring and Assessment

Viope World supports instructor's assessment in a number of ways. Viope platform supports instructors in identifying plagiarism in programming exercises. Also, completed exercises or assessment reports can be exported easily in the form of excel or html file. This makes it easy for grading.

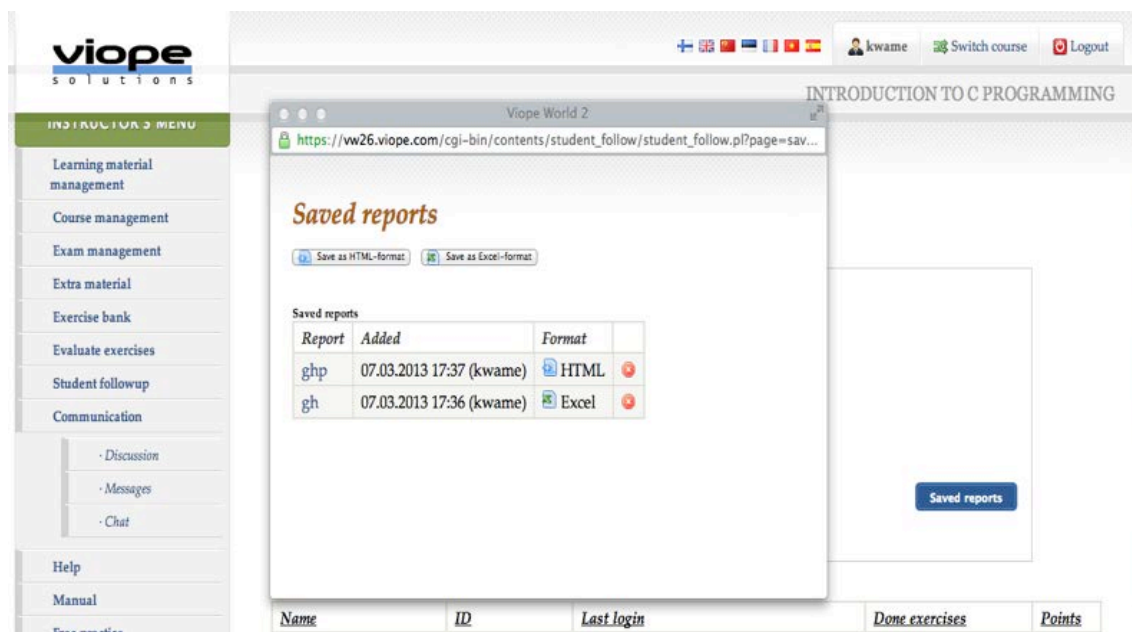


Figure 3: Viope World-Saving students report options

Viope offers enough statistical features and support for instructors to monitor the progress of individual students and whole class studies. Instructors can determine the level of the class by just looking at statistics of their progress in studies and direct their teaching to more challenging concepts. There are statistical features for how many errors a student or whole class are returning, based on this instructors can pay attention to struggling students.

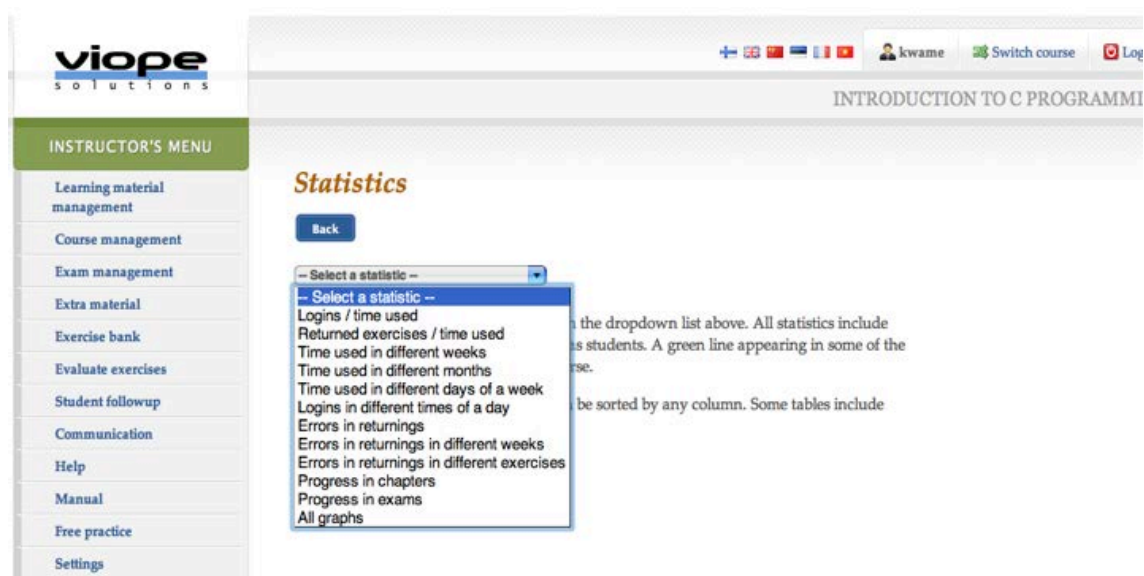


Figure 4: Viope World-Statistical feature for monitoring students study progress

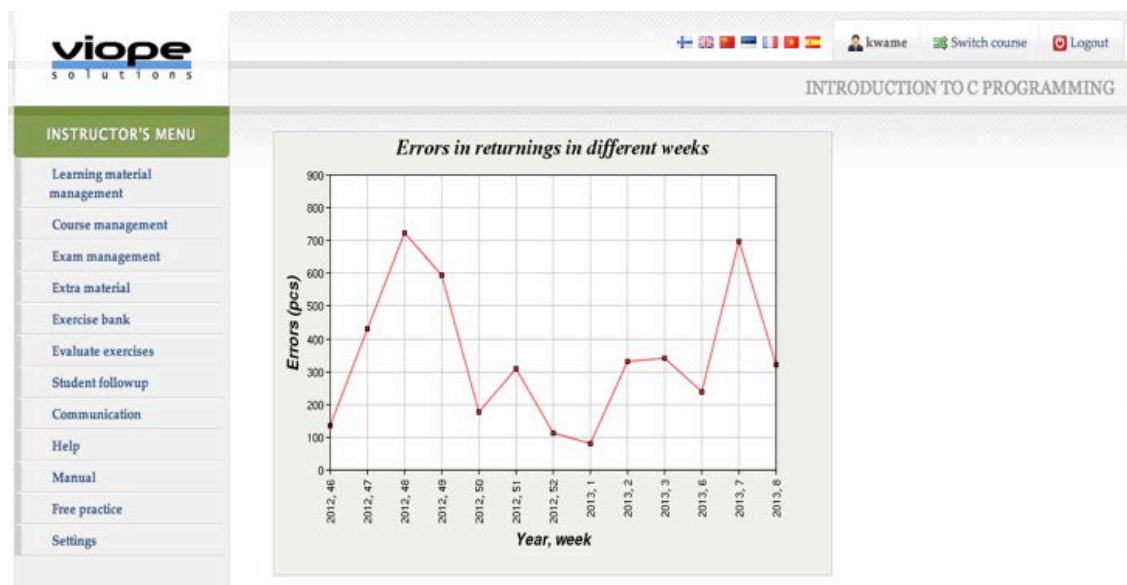


Figure 5: Viope World-graph of student's error returns

According to the chart above, it is easy for instructors to see which chapters the students are struggling with. Most of the users of Viope World open course content chapters on weekly basis. This means that with this statistics, it is easy to determine which concepts students are struggling with, so instructors can spend time with students on such concepts.

Viope tool offer students Automatic and immediate feedback on completed exercises. Others benefits include multifaceted exercises, compilers and interpreters in the web browser and an easy way to share their thoughts about course contents or completed exercises. Viope learning environment saves students the hassle or the trouble of having to prepare or set-up an Integrated Development Environment (IDE) for running their code. Programming is such a stumbling block course for most computer science students and so for novice programmers, saving them with the hassle of setting up IDE will be a good boost or motivation. (Miliszewska, Venables & Tan G 2008)



Figure 6: Viope World-IDE

Viope tool has a lot of success stories in teaching and learning programming, the issue is to see how best this tool is addressing the concerns of researchers in the problems of teaching and learning programming. For example, "Fifteen students from the Viope exercise group participated in the exam and eleven (73 %) received the grade passed. From the other exercise group, sixteen students participated in the exam and six (38 %) received the grade passed. Thus, there is a significant difference between the two groups."

Alaoutinen and Kaarna (2001)"We have noticed in our previous courses that the students often have trouble connecting the small classroom exercises with the larger laboratory projects. This tool allows the students to get extra practice with those concepts to help ensure they are understood." (Carver & Henderson 2006)

VIOPE ECLIPSE PLUGIN

Viope world as a tool also have eclipse plugin, which allows students to create projects on eclipse from the programming exercises on Viope world. Not only that, student can test and submit their solutions or code into Viope world with just a click. This makes it easy for the instructors to do their assessment. See the figures below;

Viope plugin allow students to login into eclipse with their Viope account. All courses enrolled by the student then appear for them to create projects, test and submit their code back to Viope for assessment.

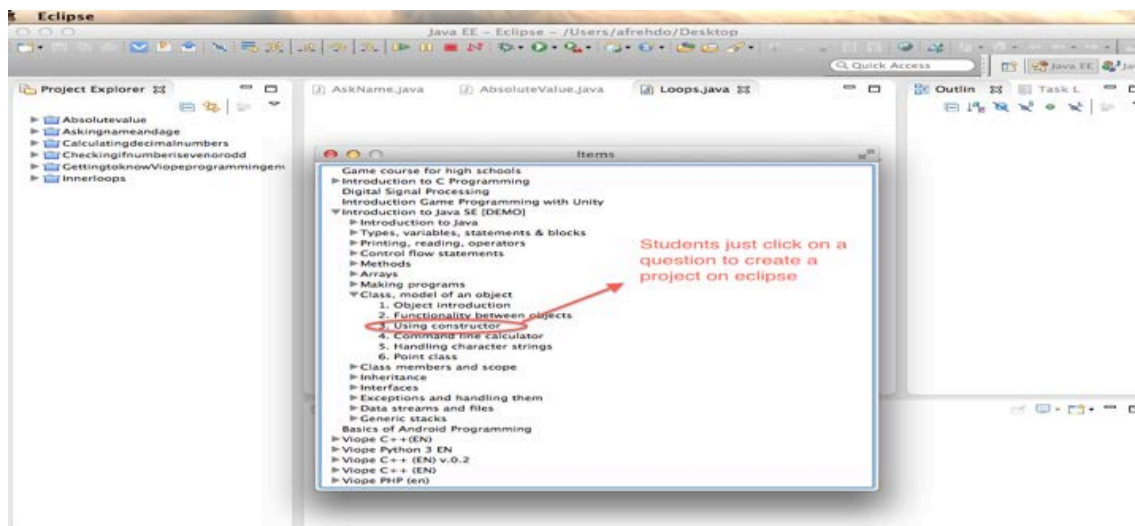


Figure 7: Viope World-Creating a new project in eclipse IDE from Viope World

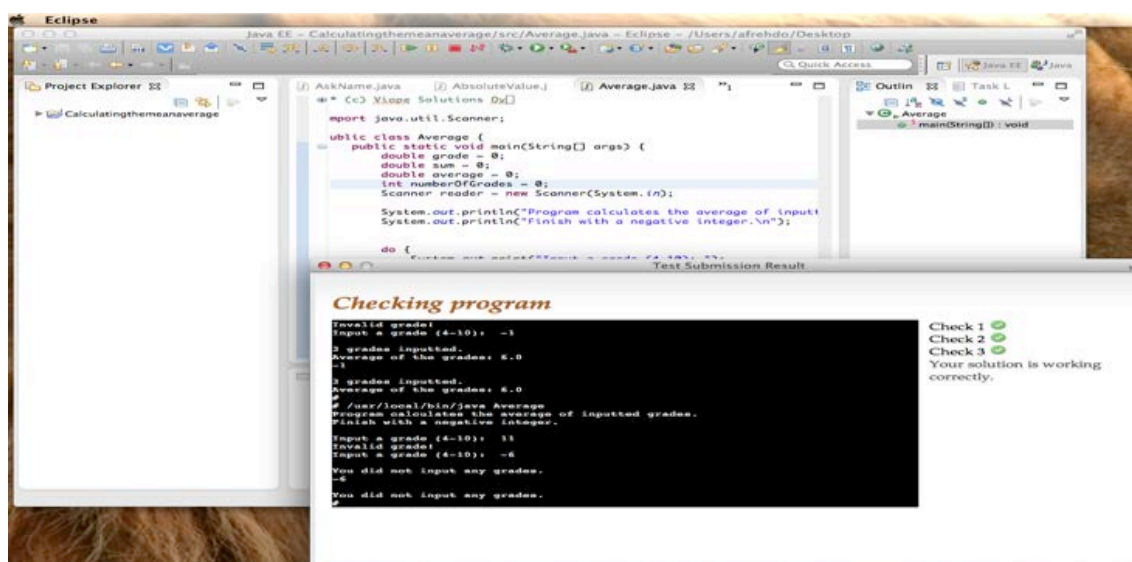


Figure 8: Eclipse IDE- Compiling your program using Viope IDE

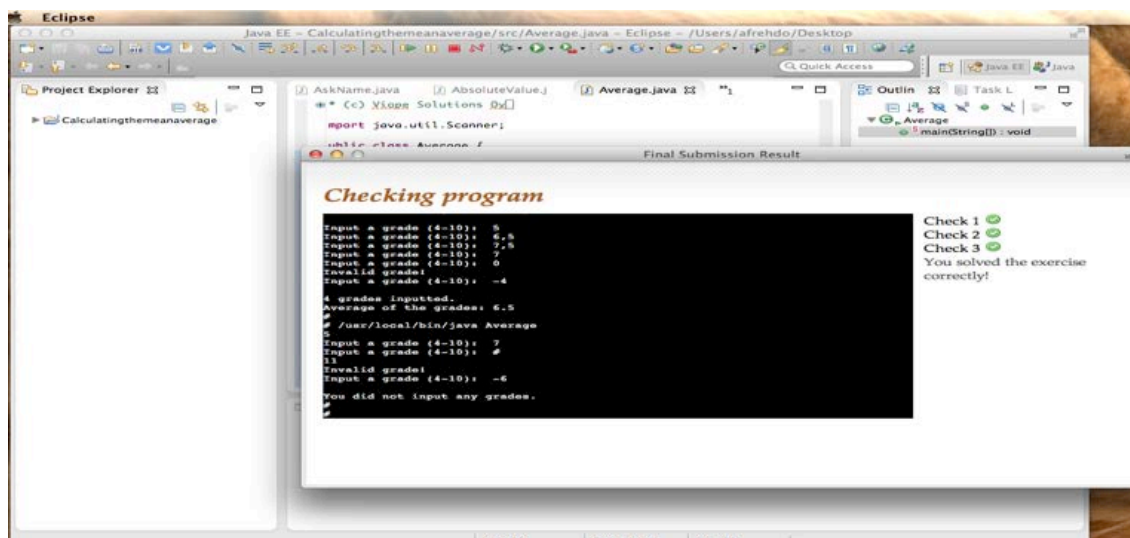


Figure 9: Eclipse IDE-Viope World running on eclipse with Viope plugin

4.4.2 Viope Programming Courses

Viope educational tool comes with already made programming courses that are editable. The platform at the moment comes with 8 programming languages which are C, C++, C#, Python, Java, Ruby, SQL and PHP.

4.4.3 Viope Game Development Courses

Viope Educational tool also comes with sets of game development courses. The game development courses include; Artificial Intelligence in Games, Video Game Design & Game Theory, Introduction to Game Programming (extended course), 2D/3D graphics and Game Business.

5 Analysis of other tools

5.1 Selected tools

21 programming e-learning tools were reviewed. Out of these 5 were selected for this thesis. Below is a list of programming e-learning tools reviewed.

Viope, Webwork, Codelab, Codingbat, MyMathLab, TALER Lab, Web-CAT, BlueJ CourseMaker, Webucator, Educsoft, BOSS, WebAssign, CodeWitz, Gradiance MycodeMath, TRAKLA 2, EasyProf, E-learning Center, ViLLE and Processing.

5.2 Criteria used in selecting the tools

The selected tools were based on the following criteria:

- If the tool is in use in many institutions
- If the tool was developed by one institution but used in many institutions
- If the tool has a demo account
- If scientific paper is found

5.3 Main focus on tool reviews

Analyses were focus mainly on the under-listed areas of the tool. For web applications such as e-learnig platform, features play a major role in its usefulness. Another area of the tools that was wealth analysing is the ways of using the tool in question.

Since the platforms in questions are related to teaching computer programming, the number of programming languages supported by the tool was also considered. Lastly, as an educational tool or platform, there was the need to see how it has been tested through research.

5.3.1 Features on both instructor and student interface

Feature, in E-learning platform, means a software item with outstanding intentional significance, which can be distinguished from others. User guidance, for instance, is an independent feature for usage illustration.

The genre of user guidance could be in documents, presentations or flash. The basic features of e-learning platform for instructors include Library Browser, Custom Question Builder, Homework sets, Class List Editor, Manual grading, Update questions types and Assign different weights to questions.

The basic features of students interface include; Skill Assessments, Materials (documentations or/and flash), automatic grading, Exercises (Debugging, Fill-in-the blanks, Matching and Short-Answer). Moreover, according to our research, there will be general

features to support the operation of E-learning such as: Interface Design, Secure Testing, Gradebook, User Guide, Course Final Exam and Accessibility.

5.3.2 Tool content or main programming languages it support

All of the e-learning platforms are used for teaching and learning programming languages. The more languages one e-learning tool provides, the easier it can be accepted and used in a wider range. On the other hand, e-learning tools, which just offer one programming language course, are generally less in beneficiary population.

The most popular programming languages which supported by the analysis tools are: Java, Python, PHP, C, C++, C# and SQL. These listed programming languages also existed in those tools: JavaScript, Standard ML, Pascal, Prolog, Scheme, HTML, XML, XHTML, CGL/Perl, Flash MX and Java Web Services. However, one or few tools support those languages.

5.3.3 Tool benefits

Benefit analysis, is literally the best and most effective way to judge one's value. By analysing the benefits one tool provides, difference could be easily distinguished. Generally, the e-learning tools help lecturers with teaching and reduce the workload of checking the homework for them.

Lecturers can put more attention on the weaker students based on the less time they spend in studying and lower score they earn. For students, automatically checking system gives immediate feedback helps them find out their weakness quickly, so they can connect for help without waiting for results.

Time saving is another major benefit e-learning tools bring to their users. E-learning tools free students from classroom and lecturers from office. Place of learning is enlarged from a specific room to anywhere with Internet.

More benefits come with use of e-learning tools and by compare and analysis, difference could be told between e-learning tools.

5.3.4 Ways of using the tool

Theoretically speaking, the more features a tool provides, and the more distinct ways of use the tool can offer. By analysing the ways of using the tool can be a criterion for judgement.

Basically all of these tools could be used for self-learning and classroom teaching. Some of them with more features can support situations such as distance-class or school that are limited in teaching resources.

5.3.5 Scientific papers written on other E-learning platforms

As an educational tool, there are mostly large amount of research papers analysing and assessing the tools in different ways. Also, available are comprises among all kinds of existing tools by experts in teaching and education. These scientific papers can be an excellent source and support while analysing the e-learning tools especially for our case company Viope.

5.4 Brief introduction of main competitors

5.4.1 Webwork

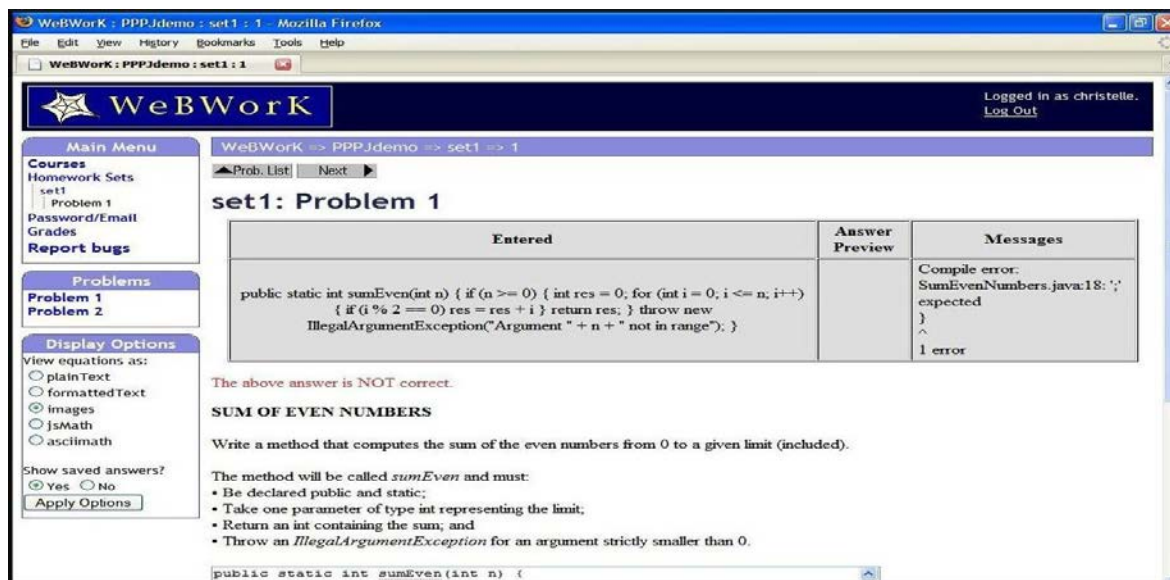
Webwork is an online homework system offering open source for math and science courses. The programming courses offered by Webwork are: C, Java, Python, SML, and Database.

Webwork is a web-based system, which provides and encourages practice with automatic response systems. It has ability to check students' homework and grade based on correctness, quality and authenticity.

The screenshot shows the WebWork interface in a Mozilla Firefox browser window. The page is titled "WebWork: PPPJdemo : set1 : 1". The main content area displays "set1: Problem 1" and "SUM OF EVEN NUMBERS". The problem description asks for a method to compute the sum of even numbers from 0 to a given limit. The interface includes a navigation menu on the left, a list of requirements for the method, a text input area for the answer, and buttons for "Preview Answers" and "Submit Answers". The bottom of the page shows "You have attempted this problem 0 times. You have unlimited attempts remaining." and an "Email instructor" button.

Figure 10: Webwork user interface

This picture above shows the main features of Webwork on the left and the right part



of the platform is a sample of programming practice.

Figure 11: Webwork- problem feedback screen

The automatic response system can give immediate feedback for users and in the meantime point out the incorrect part.

5.4.2 CodeLab

CodeLab is web-based exercises system for learning programming languages. The programming languages it provides are Python, Java, C++, C, etc.

CodeLab mentions three steps for learning a craft: first, learn by doing; second, get immediate feedback from an expert; third, first master the simple, then the complex.

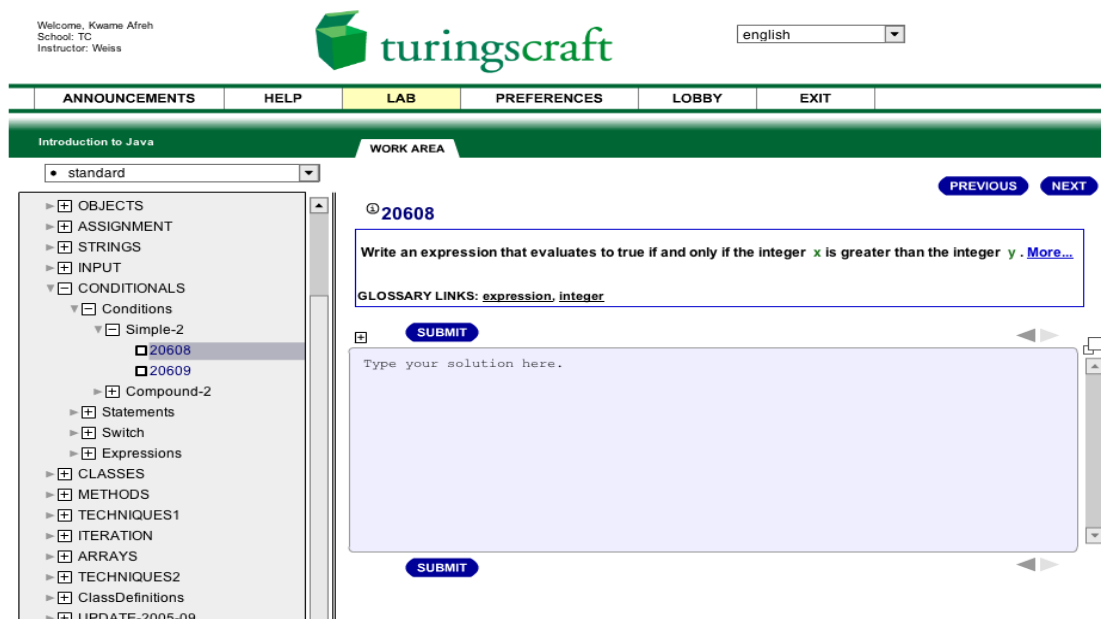


Figure 12: Turingcraft user interface

This is the basic platform of CodeLab. It contains five features: announcements, help, lab, preferences and lobby. The main documents for teaching and studying programming languages are in the feature LOBBY. Instructors can create, edit and delete teaching materials and exercises for students.

5.4.3 Trakla 2

Trakla 2 is an automatically exercise system specially designed for teaching and learning data structure and algorithm. It provides a practicing environment for students to simulate the structure. Trakla 2 is built by Helsinki University of Technology and widely used in this University.

Trakla 2 has the automatically checking systems, which can give students immediate feedback, and model answer, which can give guidance to student to understand the logic step by step.

5.4.4 CodingBat:

CodingBat is a free online coding practice for practicing Java and Python programming languages. This e-learning tool is quite suitable for students or anyone who decided to start learning Java.



Figure 13: CodingBat user interface

CodingBat is composed of a series of programming problems as the above picture. The blank board in the middle can test and run the solution user enters and if an account is created, the results and achievements will be solved in database. By checking the database, instructors can easily know the performance of each student.

5.4.5 Codewitz

The object of Codewitz is to produce and assess special illustration, animation and visualization support for teachers and students of programming. The courses Codewitz offers are Java, Operating System, C++, and Algorithms Embedded Systems.

The screenshot shows the Codewitz user interface in a Microsoft Internet Explorer browser window. The interface is divided into several sections:

- Code Editor:** Contains C++ code for a swap function using pointers. The code is as follows:


```

// Check to see if the program swaps
// the numbers by using pointers
#include <iostream.h>
void swap(int *, int *);
int main()
{
    int numb1,numb2;
    cout << "I will swap the numbers.";
    cout << "Enter two integers: ";
    cin >> numb1 >> numb2;
    swap (&numb1,&numb2);
    cout << "The numbers swapped: ";
    cout << numb1 <<" "<< numb2;
    return 0;
}
//the subfunction gets the addresses
//for numb1 and numb2 for parametres
void swap(int *a, int *b)
{
    int ext;
    ext = *a;
    *a = *b;
    *b = ext;
}

```
- Terminal Window:** Displays the output of the program:


```

I will swap the numbers.
Enter two integers:      2      5

```
- Memory Diagram:** A table showing variable addresses and contents, with a 3D diagram illustrating pointer manipulation.

variable	address	contents
ext	0x15e729b2	2
b	0x15e729c4	0x15e729e0
a	0x15e729c6	0x15e729e2
numb2	0x15e729e0	2
numb1	0x15e729e2	5
- Conditions:** A section with a question mark icon, currently empty.

Figure 14: Codewitz user interface

Codewitz offers step-by-step explanation for users to understand the programming codes and the logic behind them.

6 Data Analysis

6.1 Views of instructors from Europe

During this research, five (5) instructors who have been using Viope World for at least 3 years testimonials about the platform were analysed.

Their views has been discussed under general topics on how e-learning support teaching and learning programming but in reference to **Viope** which they have been using for years.

6.1.1 Applying in teaching

In the testimonial videos, it was clear e-learning tools are suitable for students and for teaching. To some of them, it gives a little addition to student knowledge in programming languages. Some of the lecturers use such tools as side tool for lectures and for students to practice more. An instructor responded "I use Viope tool in my working by

just getting the lecture, each chapter I open for lectures and afterwards, students are starting to do exercises from the programming exercises.”

6.1.2 Benefit of using

According to the lecturers’ testimonials, e-learning platform like Viope gives flexibility to work at your own convenient time. To some instructors, e-learning platform provides the chance to monitor students’ work at any time and see how much time they spend on it.

To others, e-learning tools improve students learning experience by way of giving them immediate feedback on exercises: An instructor responded “As a teacher, I can have 200 students. So it is impossible to teach such amount of exercise which Viope is offering to 200 students individually. So when they learn they do it by themselves, I only assist on the network.”

6.1.3 Useful features

In all, assessment features, embedded compiler and possibility to upload content and set questions. Below are also few responds of them “I think the best thing in Viope is that it has embedded platform of the compiler, so the students are not confused in installing for example separate compilers and how they function. And is also an e-learning environment, I think that is the best thing of it.”

“The most useful feature in the tool, I would say, from the teachers’ point of view, is the automatically scores keeping for each student.

So I don’t need to do anything else but open the user interface and I see how many points each student has got and it is very easy to incorporate that into the grading process” .

6.1.4 Usability and simplicity

Based on the testimonials, the tool is very simple to learn and easy to use. It takes about 30 minutes of demonstration to understand the core of the tool and five (5) days is enough to become a master user of the environment as an instructor. Logically, it is easy to navigate one’s way through the tool.

6.1.5 Connection between instructions and students

Some argue that e-learning tools distance instructors from students but to some lecturers, e-learning tools like Viope offers the chance for instructors to get even closer to weak and shy students, but of course, little contact with brilliant students. "I think it is actually the opposite, even though students who are very shy are able to work with Viope tool. And even they contact teachers more than on face-to-face contact".

"If somebody will say that Viope tool distances teachers from students, I am on the other opinion that it actually brings teachers and students closer because the teacher can concentrate on working on the acute problems of students"

6.1.6 Recommendation to future users

It was obvious the respondents were happy with e-learning tools in teaching computer programming. Some of the users have these to say, "Viope tool is incomparable to any other tool I have used". "If you are planning to take Viope into use, I will say go for it. It is very reliable system, does not let you down, and using Viope system is very easy, no difficulties at all, making any of the common tasks you would like to do"

6.2 Views of instructors from Africa

As one of the methodologies for this thesis, Viope's platform was presented in 6 universities in Africa. Al-Imamy, Alizadeh & Nour (2006) "The wide variation in the students' backgrounds, coupled with the traditional classroom (one size-fits-all) teaching strategy, and bounded course duration, makes it extremely difficult for lecturers to develop and enhanced student' needs in programming".

It is an undeniable fact that most of the institutions in Africa still depend solely on traditional classroom teaching, which in the context of teaching programming makes it more difficult for student to comprehend.

The motive behind the presentation was to find instructors views on how Viope tool addresses the challenges in teaching and learning programming especially to the novice programmers. One minor aspect was also to find out the impact of cultural difference in using e-learning tools like Viope in teaching and learning programming.

Views and questions of instructors have been discussed under the following topics; Assessment, managing and monitoring, usability, features and impact in teaching programming.

6.2.1 Assessment

Assessment has been of the major challenges in teaching and learning programming. In most cases, once the students realized that by making an effort in the programming exams instructors will award them a credit they turn to ignore the mastering of the requisite problem solving abilities.

Instructors also find it difficult to determine whether the students were progressing towards the right answer. It has been suggested that if there is a mechanism for students to see if their program works before submitting their exams they will find the opportunity to correct their mistakes.

Such mechanisms will make assessment much easier for instructors to assess students programs automatically. This form of assessment helps instructors to allow students to resubmit their program by showing them what their program should have produced without necessarily showing them the solution. (Daly & Waldron 2006)

Plagiarism in assessment is another serious issue talked about (Daly and Waldron 2006). It is therefore important that, an e-learning platform comes with such features to help instructors.

One of the frequent questions that were discussed during presentation in most of the schools in Ghana and Nigeria was on assessment. It was obvious that programming assessment was time consuming for instructors and that automatic assistance is in need.

Most of the frequent questions on assessments were;

- Can instructors see students code on the platform?
- Can instructors comment or send feedback messages on student's code?
- Can the data (grading, multiple choice test specification,) be exported?
- Which data can be exported and in what formats?
- Tools for plagiarism detection?
- Randomization of questions during exams?
- Are there possibilities to reject student's solution for resubmission?

A detail demonstration of the tool was done on the above-mentioned questions.

6.2.2 Management and monitoring

A lot of questions came from the instructors regarding the possibility and flexibility of the usage of the Viope educational tool. Among some of the numerous questions includes;

How long does it take to master the tool?

Can instructors add own or modify the content on the platform?

How do you monitor student's studies?

How do you prevent malpractices in exams, if a student login with a colleague accounts to help him/her?

Can the instructor remove or delete student's account?

The instructors were satisfied with how Viope resolved these questions but nevertheless they had good suggestions of how the services could be improved. On the issue of exams malpractices, some instructors suggested, there should be possibility for the school to restrict the account within the school's network system. This will prevent other people or students from logging in outside the network during exams.

Others also suggested the statistical part of the tool should show the IP addresses of the computers from which the account was login. This way, if the instructors detect the IP address is not within their network system, from where the exams were conducted then they can easily see there was a compromise on that account.

Many also suggested, there should be randomization of features for both management and exams monitoring. They explained that, with randomization, they could group their students into project groups with just a click. Also, this will enable them to assign different questions to students during exams to reduce exams malpractices.

They were impressed with the nature of which Viope educational tool has addressed other questions. But most importantly they commended the simplicity of the features of the tool and the possibility to master the tool within a week.

They were also impressed with the fact that, there are already made material of which they can also edit or add and also create their own on the platform. They realize with Viope educational tool, the statistical features helps to figure out weak students in order to offer the necessary help.

It was possible to compare student's performance against each other and also against chapters of the course. In this case instructors can concentrate on chapters where students are struggling.

6.2.3 Usability

On usability, most of the instructors were impressed with simplicity of the features of the tool. Most of them admitted that, as much as they want to blend their traditional teaching with e-learning platforms, they are always concerned with the usability since the level of the students in information technology is not that high.

It was therefore, a priority for most of them to have a simple and user-friendly tool like Viope. What was so amazing to them was the fact that, the features of the tool are customizable. They can rename them even in their local language. Navigating through the platform was also easy based on the presentation.

Again, some of the instructors were also satisfy with *visual design and interactivity* of the Viope Educational tool.

6.2.4 Features

Even though, the instructors were so amazed with the features of the tool, nevertheless they suggested a couple of good features such as; randomization of question and answers for examination purposes, possibility for the platform to detect computer Internet protocol address to also aid in conducting free and fair examination, rejection button for student submission for resubmission, peer assessment, among others.

6.2.5 Tool impacts on teaching programming

Based on the results of how Viope platform has been used in Lappeenranta University of technology and Mississippi State University together with platform presentation and trial, majority of the instructors were convinced with the out of the use of the tool. One instructor from Ghana said "The feedback I have received from some of the students who had the privilege to use Viope tool is just incredible.

7 Conclusion

The methodologies chosen for this thesis was really useful as a lot of issues in teaching and learning programming were revealed. At the same time, numerous constructive suggestions were made by various lecturers on how to even make Viope Educational Platform better. Most of the suggested features are already been implemented on the platform.

In spite of the effort put into this thesis work for this achievement and contribution to making the teaching and learning easier for both instructors and students, much is still required to even make it better. Recommendations have been made below, which should be taking into account by e-learning platforms developers.

Especially with the new Massive Open Online Course (MOOC), there is the need to take a critical at platforms which will not online present content to students or aid instructors only in presenting their lectures but rather show or have some support for the students.

7.1 Challenges

Looking at the methodologies choosing for this thesis, it is obvious the researches have a lot challenges. Below are few of such described?

7.1.1 Travelling

The research method Presentation required the researchers to travel from Finland to Ghana and Nigeria. During the months of January -March 2012, there was a lot of riots in Nigeria, which made it impossible to arrange meetings. The travelling around Nigeria in general was risky. Not all planned university visit were accomplished due to the political unrest situation.

7.1.2 During workshop

Viope Educational Platform is web-based and as such required Internet to be able to present at workshops. During most workshops, Internet at the universities was slow, not working or there was power cut. All these, at any point were a real challenge as it sometimes destruct schedule in a particular day.

7.1.3 Arranging Meetings

Bureaucratic system of administration made it difficult to get a letter requesting for presentation approval. Sometimes, it takes close to two or more months to get a request approved.

7.1.4 Getting the right contact

Mostly, contacts given on websites were not working or the respondent was not the one expected. Several calls were made just to get one in charge of such presentation arrangement.

7.2 Recommendations

7.2.1 User Interface

User interface is important part in developing any e-learning platform or any web application for instance. The flexibility for students to effectively learn using the platform depends on how simple and supportive the user interface is. E-learning platforms user interface design is critically essential, because the effectiveness of learning and the design of the interface are greatly intertwined. (Guralnick 2006)

7.2.2 Features

Viope platform have simple and numerous features that suit students, nevertheless the platform may even be useful in addition to the following suggestions.

One major issue with cloud- based tools is its ability to be used fully for conducting examinations and assessments. For that reason, it is essential to include randomization of questions to avoid cheating in examination.

“Randomization of students into groups or projects” is one important feature, which does not exist yet. For school days and future work, group or teamwork is always the main form of existence for doing programming project. Few people can finish one huge project all by themselves.

It is important that students work individually and in groups, creating solutions to problems, correcting and refining them, until a correct solution is achieved.” It is emphasized the importance of group-problem-solving skills for students. This feature simu-

lates the group project tasks, which need joint efforts like real tasks in IT career. (Mendes, Ivanov & Marcelino 2005)

It helps lecturers spread students into groups randomly and gives opportunities for students to gain their ability to work as a team with different colleagues. Several items form this feature: grouping members, milestones, participation and time-spent on final results and presentation.

One of the other important features is "peer assessment". This is a simple feature, which enables students to give scores to others' assignment of their peers after the deadline. Based on these behaviors, students get to know the standards of how to judge good projects, learn their weakness and refresh their minds from others' brilliant thoughts. Lecturers can also learn how a student's understanding based on student's grading to each other and the comments they give.

Visual or graphical feature is the update feature on the main feature programming tasks in students interface. It was suggested that an output screen should be added so that students can see the immediate response from the languages they type. This immediate response helps students understands programming language quicker than just do the exercise and know the results.

7.3 Improvement in existing features

7.3.1 Assessment

Nowadays, in programming tasks, most compilers of e-learning tools cannot process multiple answers. The only right answer it authenticates is the one lecturer enters into the checking systems. The compiler checks the students' answer and the "right answer" line by line and slight difference might lead to wrong judgments.

This checking system is not suitable for real programming language tasks because most of the tasks can be achieved by multiple ways. The compiler should be updated and checking the answers by the outputs and the logic of the language instead of just checking the words. For lecturers, new checking systems helps getting to know the level of students and also know the students' logical thinking when facing one programming tasks. By knowing all these, lecturers can give accurate suggestions.

7.3.2 Interactivity

Without doubt interactivity plays a major role in any web application being it with one user or between users. Viope World as an educational tool for instructors and students has got numerous interactivity features for both students and instructors.

Nevertheless, few improvements such as possibility for students to cancel their own exercise submissions and resubmit, students/instructors to able to set answered exercises as unanswered to allow for multiple practice will be very useful in some cases based on this research.

7.3.3 Usability

With the fast growing pace of information technology today, computer is not the only choice for people to connect to the Internet. Smartphones and tablets, personal computer are new platform for surfing the Internet.

As the benefit of convenient and place-unlimited, good e- learning platform should seriously consider spreading its business into Smartphone, tablet and PCs. With the widespread of 3G and Wi-Fi hot spots, these two could be a perfect platform for e-learning tools.

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Video links

Kwame's Presentation Introduction Ghana

<https://www.youtube.com/watch?v=GbNTEqs0Uts>

Kwame Afreh's presentation-Garden City University College Ghana

<https://www.youtube.com/watch?v=kLkbp0L2m-E>

Kwame Afreh's Presentation-Garden City University College Ghana

https://www.youtube.com/watch?v=XH3H_DfBoDg

Kwame Afreh's Presentation-Garden City University College-Ghana 2

https://www.youtube.com/watch?v=fnUpFu_87_A

Presentation at Babcock University-Nigeria

<https://www.youtube.com/watch?v=Qs25I-5JOsc>

Presentation at Babcock University -Nigeria 2

<https://www.youtube.com/watch?v=NXHvEX1r70s>

Kwame's Presentation-National Open University Nigeria

<https://www.youtube.com/watch?v=7Ykye27mIBg>

Testimonial Videos Links



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Garden City University College-Ghana



National Open University-Nigeria



National Open University-Nigeria



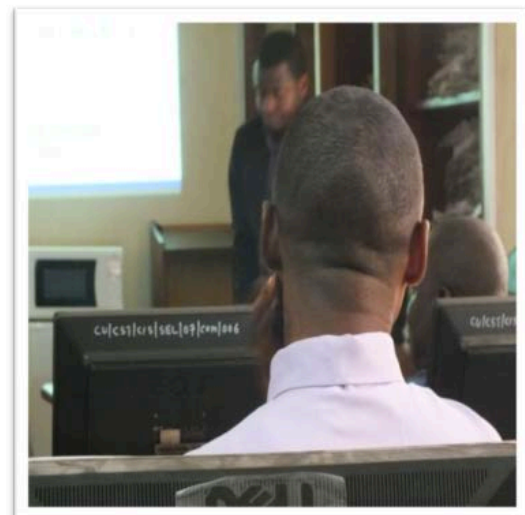
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Covenant University -Nigeria