
Open source in STEM program for effective learning in developing nations

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Abstract:

Since there are not sufficient funds to support STEM education in developing nations, thus, open source applications would be the solution to this dilemma. Open source software technology depends on collaborative work among people from all over the world, therefore, students in developing nations can gain their experiences while they are contributing to open source projects and earn their degrees while they are at their home county and no need to travel to study abroad. Schools can utilize STEM open source for teaching that leads to build robust education for students and help build their future and move out of poverty.

In this paper we discuss Open source as tools and applications to enhance students learning in STEM education. Examples of open sources, Oracle VM VirtualBox and Linux Fedora will be discussed in this paper. Best practice of STEM projects in classroom based on open source application will be demonstrated. Assessment results will be analyzed. This might inspire freshmen students and empower women to enter STEM education field in developing countries.

Introduction:

In developing nations, there are many causes for lack of education. The common ones are inequalities that create in sex, health and cultural identity, poverty and economic challenges. This can be seen in big families who decide not to send their children to schools instead they force them to work and support their families and not benefit from learning which is vital to their intellectual and social development [1]. The majority of the people in the developing nations live under poverty line. For example, South African median employee earns R2800 a month (USD 219.45), Zimbabwe employees earn an average salary around \$250, and Nigerian employees earn about \$290 [2-3]. The majority of developing countries lack the financial resources necessary to create schools and provide schooling materials and educational resources for students. Funds are generated from the international communities that are generally not enough for developing nations to establish an education system for students who are ended up without education.

In this paper, we will discuss a framework and best practice for schools to use in an absence of financial resources. Students can use Raspberry Pi since it is less expensive than a computer and use Open Source Software that is an important key in collaborative learning. The advantages of collaborative work are to promote of student-faculty interaction, develop higher-level thinking skills and improve class retention and persistence. Since Open Source Software is free so it has great benefits such as cost, flexibility and is always on the cutting-edge of technology.

Building project frame work

In this paper, Open Source Software such as Oracle VM VirtualBox and Fedora Linux were utilized. It was used mainly in CIS206 class at DeVry University in Orlando, Florida. The purpose of this study is to promote Open Source Software that makes a huge impact on student success. The outcomes can be measured based on student learning experience. Students used computers or Raspberry Pi and Open Source Software to design a project. Raspberry Pi can be an alternative solution to a computer, which works as if a normal computer at a reasonably low price. This can decrease financial burden on college budget thus, it fits well in developing nations.

The CIS206 class was offered in different sessions at DeVry University in Orlando, Florida, in January 2013 session, in November 2014 session and in July 2015 session as shown in Table 1.

Table 1: CIS206 class Offerings

Academic year	Session taught	Number of students enrolled
2013	Jan session	10
2014	Nov session	9
2015	July session	9

In July 2015 session, students had to design several small hands-on projects. For example, Vending machine project was assigned to students that leverages their own problem-solving skills and improves their learning experience. Students in class have worked in teams of three where they utilized Oracle VM VirtualBox and Linux environment. Since Fedora Linux v23 and Oracle VM VirtualBox were Open Source Software, therefore they were available for students to install at no cost as shown in Figure 1.

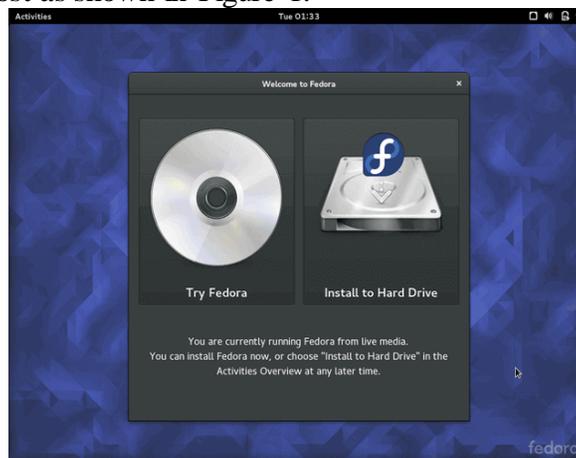
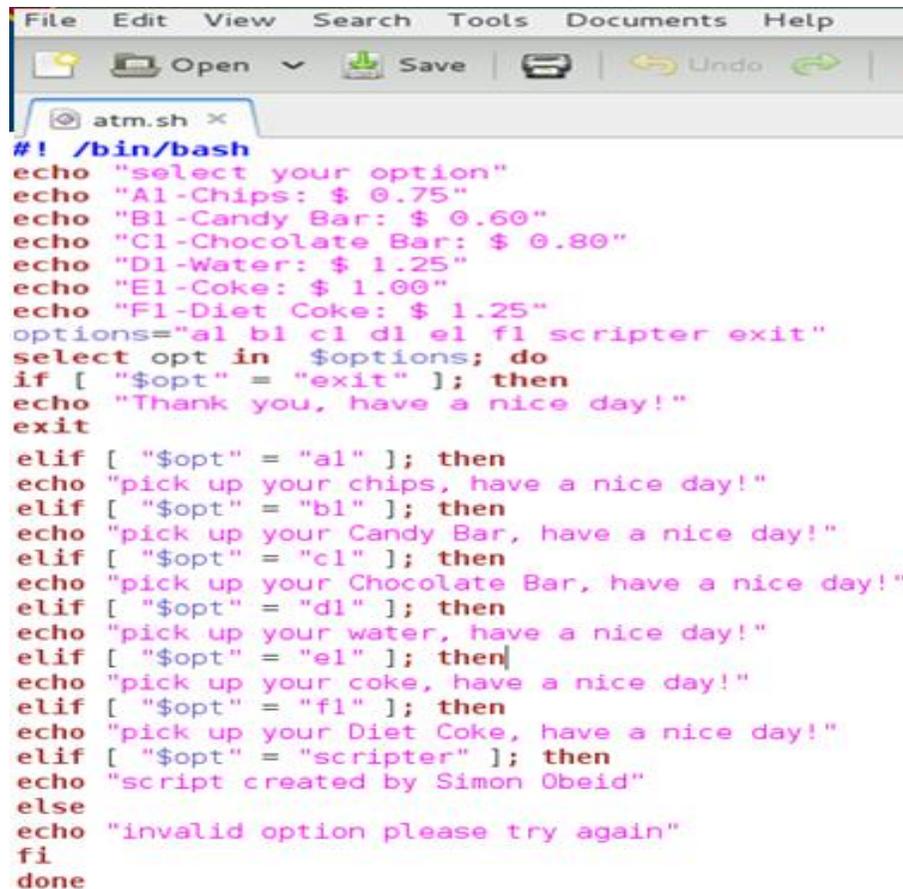


Figure 1: Oracle VirtualBox and Fedora Linux v23

After students completed installing Oracle VM VirtualBox and Fedora Linux, they used any of text editors for Unix/Linux such as Vim or gedit to create and run a bash script as shown in the Figure 2.



```
File Edit View Search Tools Documents Help
Open Save Undo
atm.sh x
#!/bin/bash
echo "select your option"
echo "A1-Chips: $ 0.75"
echo "B1-Candy Bar: $ 0.60"
echo "C1-Chocolate Bar: $ 0.80"
echo "D1-Water: $ 1.25"
echo "E1-Coke: $ 1.00"
echo "F1-Diet Coke: $ 1.25"
options="a1 b1 c1 d1 e1 f1 scripter exit"
select opt in $options; do
if [ "$opt" = "exit" ]; then
echo "Thank you, have a nice day!"
exit
elif [ "$opt" = "a1" ]; then
echo "pick up your chips, have a nice day!"
elif [ "$opt" = "b1" ]; then
echo "pick up your Candy Bar, have a nice day!"
elif [ "$opt" = "c1" ]; then
echo "pick up your Chocolate Bar, have a nice day!"
elif [ "$opt" = "d1" ]; then
echo "pick up your water, have a nice day!"
elif [ "$opt" = "e1" ]; then
echo "pick up your coke, have a nice day!"
elif [ "$opt" = "f1" ]; then
echo "pick up your Diet Coke, have a nice day!"
elif [ "$opt" = "scripter" ]; then
echo "script created by Simon Obeid"
else
echo "invalid option please try again"
fi
done
```

Figure 2: Designing vending machine in bash scripting based Linux

After designing the program, the students were able to set up file permission to be run and executed. The students were capable of testing the program and retrieving results based on their requests as shown in figure 3.

```
File Edit View Search Terminal Help
[simonobeid@localhost ~]$ bash atm.sh
select your option
A1-Chips: $ 0.75
B1-Candy Bar: $ 0.60
C1-Chocolate Bar: $ 0.80
D1-Water: $ 1.25
E1-Coke: $ 1.00
F1-Diet Coke: $ 1.25
1) a1          3) c1          5) e1          7) scripter
2) b1          4) d1          6) f1          8) exit
#?
1) a1          3) c1          5) e1          7) scripter
2) b1          4) d1          6) f1          8) exit
#? 1
pick up your chips, have a nice day!
#? 2
pick up your Candy Bar, have a nice day!
#? 3
pick up your Chocolate Bar, have a nice day!
#? 4
pick up your water, have a nice day!
#? 5
pick up your coke, have a nice day!
#? 6
pick up your Diet Coke, have a nice day!
#? 8
Thank you, have a nice day!
[simonobeid@localhost ~]$ █
```

Figure 3: Testing the project

Assessment approach:

Summative assessment strategy was implemented using hands-on activities and mini-projects evaluations in class to measure student performance. There was also comprehensive exam that measures overall student learning at the end of a course. Table 2 summarizes average grades of CIS206 class based on each category such as homework, ilab, final exam...etc per session.

Table 2: Average grades of CIS206 class per session

CIS206 grades categories	Average grades of CIS206 in Jan 2013 session	Average grades of CIS206 in November 2014 session	Average grades of CIS206 in July 2015 session
ilabs	70	78	90
Homeworks	77	80	88
Discussion Questions	90	91	93
Final exam	80	90	91
Class average	79.25	84.75	90.5

The lowest average grades were 70/100 for ilab in Jan 2013 session and the highest grades for ilab was 90/100 in July 2015 session. This improvement is due to student's engagement and their collaboration using Open Source Software and virtualization in classroom. The information was plotted in a chart as shown in Figure 4.

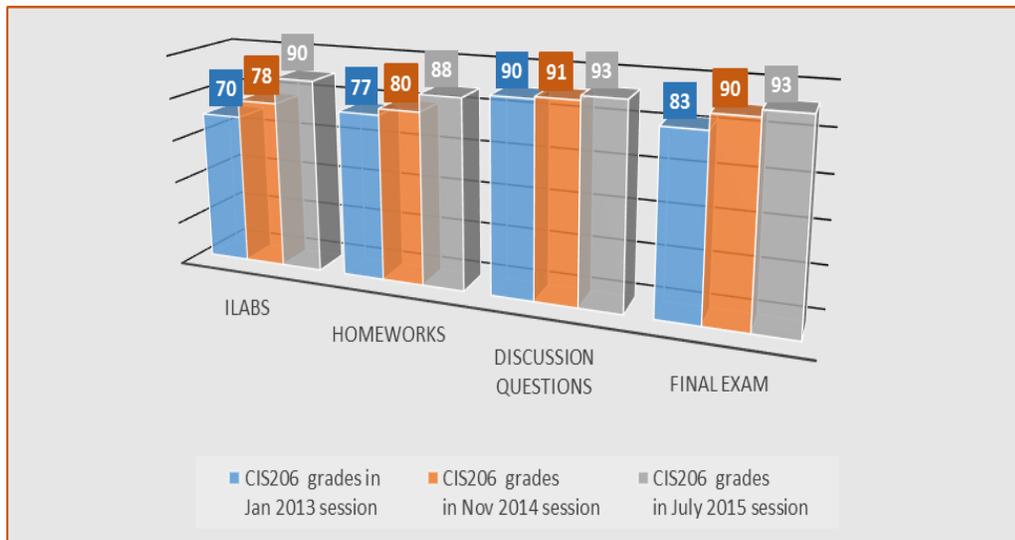


Figure 4: Students grades in CIS206 class based on different categories per session

Figure 5 shows the average grades for CIS206 class per session where the highest average class grades were 90.5 in July 2015 and the lowest average grades were 79.25 in Jan 2013 session.

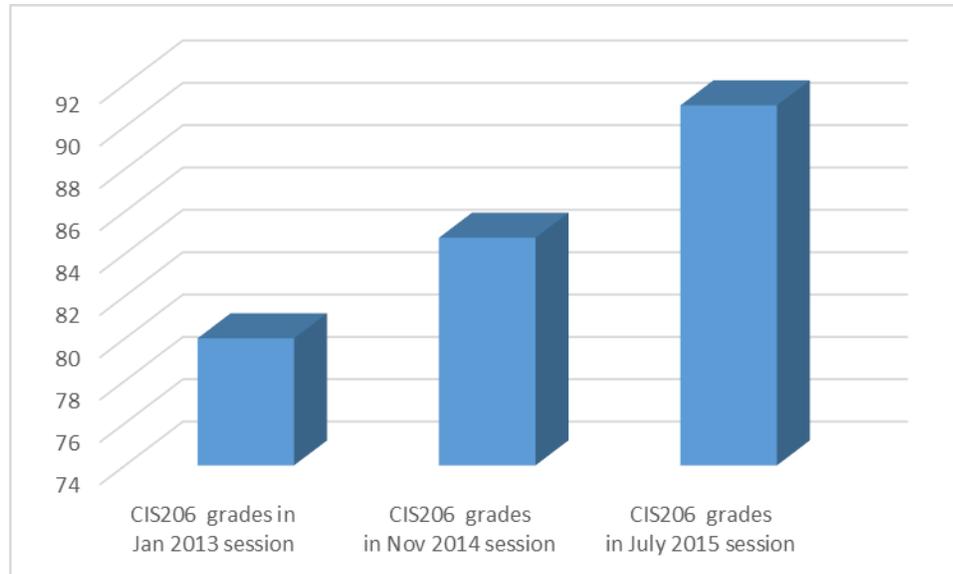


Figure 5: Average class grades per session

Applying multiple learning techniques are important to ensure that students who may perform poorly with one method or at one time have an opportunity to demonstrate learning through multiple methodologies through student collaboration and hands-on projects...etc. As discussed in pervious section, summative assessments and formative assessments were implemented.

Based on student outcomes, it was found that student's grades have improved between Jan 2013 and Nov 2014 sessions and Jan 2013 and July 2015 as shown in Figure 6 and 7 respectively. This analysis proves that this project can increase students' engagement, improve their grades and reduce the cost of software and hardware used thus; the project can be implemented as a pilot study in developing nations.

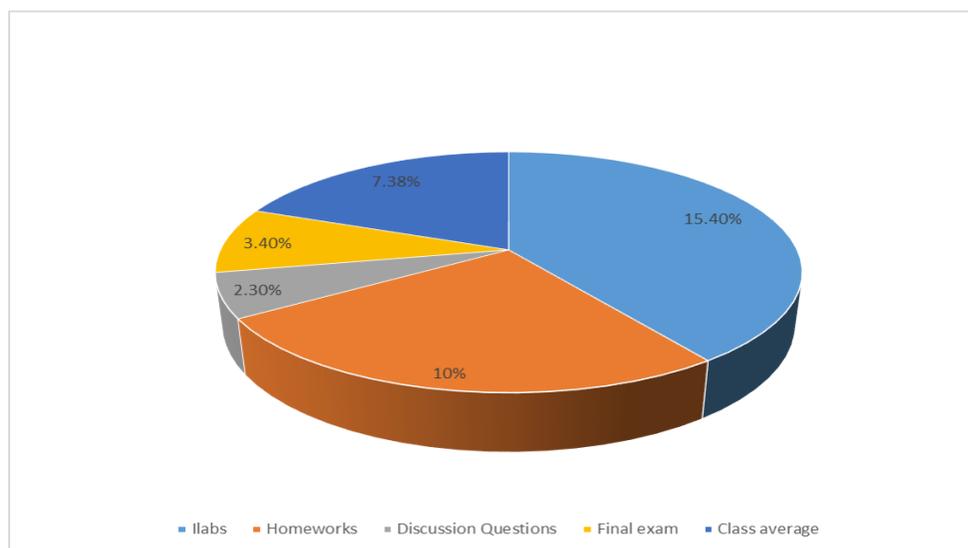


Figure 6: Grades percentage growth between Jan 2013 and Nov 2014 sessions

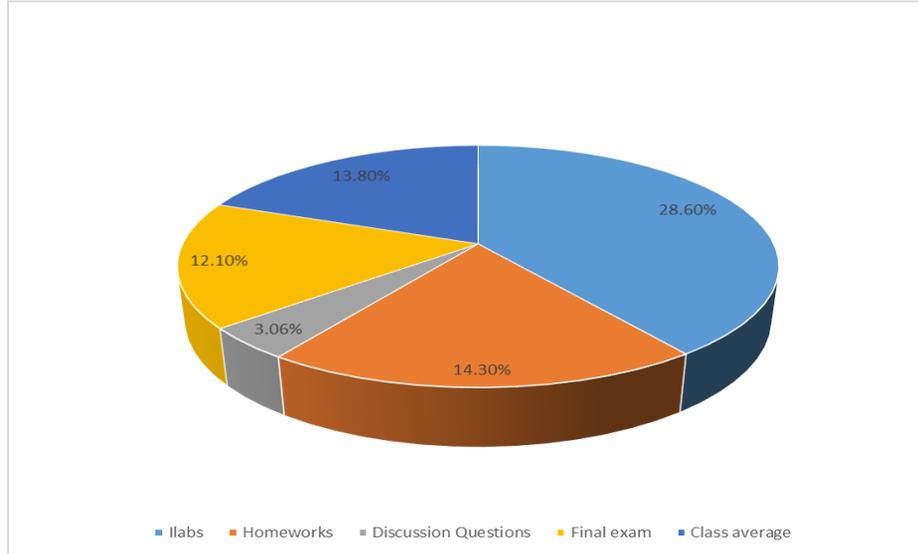


Figure 7: Grades percentage growth between Jan 2013 and July 2015 sessions

Conclusion:

The results demonstrated a successful technique that improved student persistence and success rate and increased their collaboration. This project used Oracle VM VirtualBox and Fedora Linux as Open source that can be implemented in many areas of STEM education. It is important to integrate this kind of activity into STEM curriculum and select the active learning strategy that works best for students. The goal was to engage students in hands-on project and to transform their learning from passive to active learning and create cohesive practice interaction in class. Open Source Software is a great tool to decrease financial burden on college budget and student spending since it is free of charge.

This project demonstrates a successful collaborative learning framework that reduces school expenses and uses Raspberry Pi that works as a normal computer at a relatively low price with Open Source Software. This proposal can fit well in developing nations where students can be part of Open Source project team that builds upon community support and project collaboration. It also provides students with the right skills to have better life and prepares them to be valuable asset in the workplace.

References:

- [1] <http://www.humanium.org/en/world/right-to-education/>
- [2] [Zimbabwe Revenue Authority \(ZIMRA\)](#)". Retrieved 5 March 2016.
- [3] <https://politics.naij.com/358097-salaries-in-nigeria-statistics.html>
- [4] Fedora Linux project <https://start.fedoraproject.org/>
- [5] Oracle VM Virtualbox <https://www.virtualbox.org/>