# Experience on a Mikrotik certification course using GNS3 and real devices for practices

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**Abstract:** The use of simulation software tools has demonstrated to be very useful in computer network teaching and learning processes for so long. Many advantages can be enumerated, but the outstanding one is a significant reduction in network devices acquisition cost such as routers, switches, wiring. Moreover, there is a time reduction on conventional physics laboratories launch (start-up). This article describes a study made in Mikrotik certification program context. It was organized by CIDIA (Centro de Investigación y Desarrollo en Informática Aplicada). This center depends on the Salta National University (UNSa) in Argentina. The main study goal was to compare and contrast learning between students using laboratories with GNS3 simulation software tool and those with real equipment.

**Keywords:** simulation, network teaching, virtualization, GNS3, Mikrotik

## 1   Introducción

Network concepts and fundaments are difficult to assimilate. That is because of the complexity of the involved processes that are not always visible [1], [2], [3] and [4]. ]. Specific equipment required to stand up a network laboratory are very expensive. Besides, scarce resources are a common reality in most argentine national universities located in provinces. In this context, simulation software tools emerge as a possible solution to make the most of the students' practices by making, also, possible the use of these tools out of classes' schedule (Virtual laboratory).

According to what has been stated before, the difficulties can be summarized as follows:

- The teacher has to adequate work practices to the characteristics of the equipment available. Equipments are generally scarce.
- The number of students is normally high.
- Network devices (routers, switches, wiring, etc) are expensive. Their updating and maintenance involve high costs. That is the reason why there is usually only one or at least two devices per students group. This makes real equipment laboratories unviable.
- Not all topics can be tackled with a real environment practice
- The learning curve to manage devices in real laboratories is high. The same occurs with physical links in order to define a certain topology because there are available different kinds of interfaces such as Ethernet, FastEthernet, Serials and Consol Ports. This makes impossible the access to the network hardware difficult for many groups.

## 2  Contextual frame

The experience was carried out with a group of students that were taking a course in which the main goal was to get Mikrotik certification. The course was organized by CIDIA, a research and development center that belongs to the Salta National University. Topics covered were very wide and extend, having 9 modules with subjects as RouterOS introduction, RouterBOARD, DHCP, Bridging, Routing, Wireless, Firewall, QoS, Tunnels, Misc. GNS simulation workshop took place at the end of the course and only for static and dynamic IP routing with RIP and OSPF. Ten students out of twenty five attended this workshop.

The main objective of this studio was to compare and contrast the same practice activity working with real Mikrotik equipment and with GNS3 simulator. A survey divided in three parts was given to the students. The first part inquired about the simulator use and its ease to configure a topology, configure devices, check functionality and track events. The second part presented the same questions but related to a real devices laboratory. The last part examined the possibility of replacing real equipment laboratory with simulators when the objective is teaching network concepts and fundaments. Clearly, computer network teaching in environments such as universities is different from the specific training that network technicians need because for them it is crucial to work with real equipment from different providers.

## 3  Data Statistic Analysis

The arithmetic average for these data exceeds, in all cases, at least the scale medium value (3,00). That confirms the content validity of all items included in the survey.

The Cronbach's alpha coefficient calculated is 0.68. This value does not surpass the 0.7 value. Nevertheless, the questionnaire reliability grade can still be confirmed. Therefore, minor polarization in reliable answers can be appreciated.

Bellow, data statistic analysis for each part of the survey is presented

### 3.1 Using GNS3 simulation tool

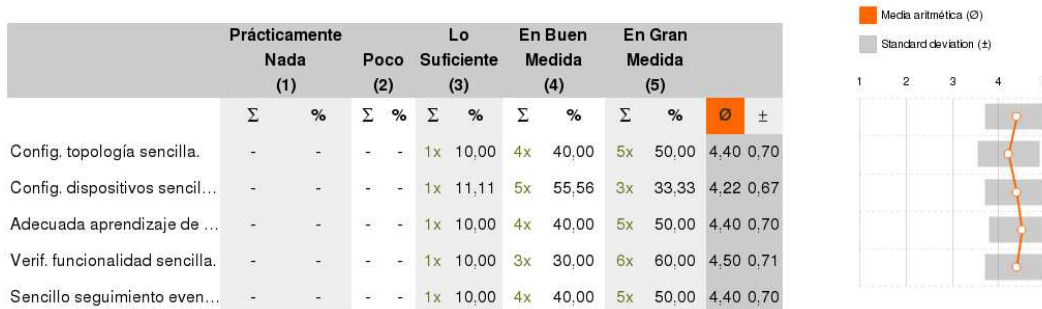| | Prácticamente Nada (1) | | Poco (2) | | Lo Suficiente (3) | | En Buen Medida (4) | | En Gran Medida (5) | | Ø | ± |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Σ | % | Σ | % | Σ | % | Σ | % | Σ | % | Ø | ± |
| Config. topología sencilla. | - | - | - | - | 1x | 10,00 | 4x | 40,00 | 5x | 50,00 | 4,40 | 0,70 |
| Config. dispositivos sencil… | - | - | - | - | 1x | 11,11 | 5x | 55,56 | 3x | 33,33 | 4,22 | 0,67 |
| Adecuada aprendizaje de … | - | - | - | - | 1x | 10,00 | 4x | 40,00 | 5x | 50,00 | 4,40 | 0,70 |
| Verif. funcionalidad sencilla. | - | - | - | - | 1x | 10,00 | 3x | 30,00 | 6x | 60,00 | 4,50 | 0,71 |
| Sencillo seguimiento even… | - | - | - | - | 1x | 10,00 | 4x | 40,00 | 5x | 50,00 | 4,40 | 0,70 |

**Figure 1:** Analysis working with GNS3 simulation tool

Here, 90% of the students considered that topology configuration was simple with simulators, 88% considered that devices configuration was simple, and, 90% considered that functionality verification and events tracking were simple with the simulator.

### 3.2 Working with Mikrotik real equipment

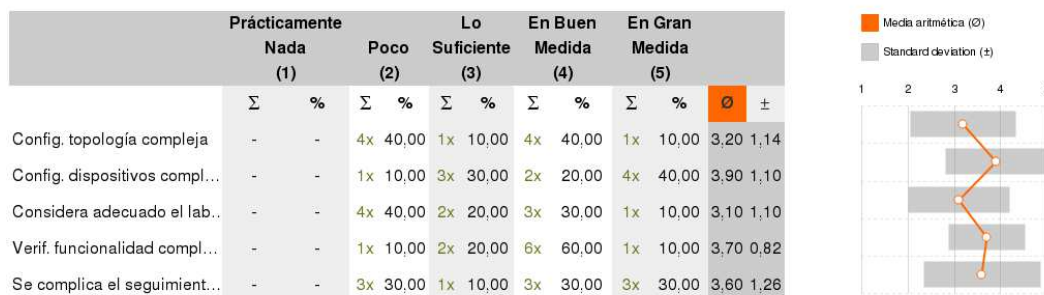| | Prácticamente Nada (1) | | Poco (2) | | Lo Suficiente (3) | | En Buen Medida (4) | | En Gran Medida (5) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Σ | % | Σ | % | Σ | % | Σ | % | Σ | % | Ø | ± |
| Config. topología compleja | - | - | 4x | 40,00 | 1x | 10,00 | 4x | 40,00 | 1x | 10,00 | 3,20 | 1,14 |
| Config. dispositivos compl… | - | - | 1x | 10,00 | 3x | 30,00 | 2x | 20,00 | 4x | 40,00 | 3,90 | 1,10 |
| Considera adecuado el lab… | - | - | 4x | 40,00 | 2x | 20,00 | 3x | 30,00 | 1x | 10,00 | 3,10 | 1,10 |
| Verif. funcionalidad compl… | - | - | 1x | 10,00 | 2x | 20,00 | 6x | 60,00 | 1x | 10,00 | 3,70 | 0,82 |
| Se complica el seguimient… | - | - | 3x | 30,00 | 1x | 10,00 | 3x | 30,00 | 3x | 30,00 | 3,60 | 1,26 |

**Figure 2:** Analysis working with Mikrotik real equipment

In this situation, 40% of the students considered that topology configuration was simple with real equipment. Only 10% considered that devices configuration and functionality verification were simple and 30% considered events tracking was simple while working with real equipment.

### 3.3 When the objective is teaching network concepts and fundaments and not preparing network technicians, Do you consider that simulation can replace the real equipment practice?

| | Prácticamente Nada (1) | | Poco (2) | | Lo Suficiente (3) | | En Buen Medida (4) | | En Gran Medida (5) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Σ | % | Σ | % | Σ | % | Σ | % | Σ | % | Ø | ± |
| Simulación reemplaza eq… | - | - | - | - | - | - | 6x | 60,00 | 4x | 40,00 | 4,40 | 0,52 |

**Figure 3:** Simulation vs. Real equipment analysis

60% of the students considered that simulation can replace real equipment laboratory when the main goal is teaching fundamentals.

## 4  Students comments and suggestions

Bellow, there are two opinions made by students related to the experience they had while working with simulation.

- *At the time of making practicing if we do not have equipment it is very interesting to work with simulators. They let us visualize how topologies and functionality are going to be.*
- *In general terms, the experience was very good. With simulation, configurations can be rapidly reached as if they were made with real equipment. As a suggestion, it would be good to include some real equipments practice so it can be combined with simulated ones.*

## 5  Conclusions

Considering that the addressee of this course were network engineers and technicians that perform network configurations, it could evince in the analysis made, that students understood that simulation simplified the topology and devices configuration process, as well as the functional verification and event tracking. Also, they have considered that practices with simulation can replace practices with real equipment when the objective is to learn network concepts and fundamentals. It should be pointed out that the results obtained in this research study present similarities with others studies made by the same research group on network subjects at the Salta National University.

Additionally, this study presents similarity with others made by teachers of network subjects from different universities of Argentina in 2016 [13]. In that work, teachers considered that the topology and devices configuration learning curve is short working simulation software; but it is long when working with real equipment. Most of them considered that it is possible to replace real equipment practice with simulation practice when the objective is teaching network fundamentals.

## 6  Future work

As future researches, studies related about the impact of software simulation in other network scopes are suggested. Also, it is important to value the influence of this tool in other educational levels. Other quantitative and qualitative researches that lead to know with grater profoundness the conceptualization level gained by students because of the simulation software use and also that lead to a wider vision of the theme, are recommended.

Regarding the study weakness, it should be kept the small sample size in mind, so research conclusions can not be extrapolated to other contexts.

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