LKDF Interact: Implementation at the Volvo Selam Vocational Training Centre

An Evaluation report

February 2015

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Introduction

In 1996, an American marketing specialist, Faith Popcorn, in her book ‘Clicking’ for example, described the ability of Virtual Reality (VR) to “allow the student to take a painting lesson with Michelangelo or learn dramatic structure from Shakespeare”. Clearly, we have yet to reach this level of technical sophistication, and perhaps never will.

Writers and commentators often use the term “VR” to illustrate a bright and shiny hi-tech future, whilst its’ more mundane uses in education and training have all but gone unrecognised.

However, rapid and continual developments in the Information and Communication Technology (ICT) arena have led to the situation whereby VR (or interactive 3D simulations) are no longer associated only with expensive display systems, but are being used to equal effect on PCs and notebooks, and more recently, Tablets and Smart Phones.

The potential impact in education is enormous, and more organisations are starting to take cognisance of this potential, and embark on developmental initiatives that take advantage of 3D.

In mid-2014, UNIDO, through the LKD (Learning and Knowledge Development) Facility, and supported by Swedish International Development Agency (Sida), embarked on a 3D interactive / augmented reality project at the Volvo Selam Vocational Training Centre in Addis Ababa, Ethiopia.

Volvo’s interest in the Selam Vocational Training Centre is to support specialised skills development that will improve access for Ethiopian youth to gainful employment opportunities.

This project was undertaken in collaboration with EON Reality, a US-based company that specialises in interactive 3D systems, content development and knowledge transfer. This augmented reality project addresses “Diesel Engine Operation”, now commonly referred to as “LKDF Interact”.

**LKDF Interact** represents EON Reality’s first pilot project with UNIDO and a first step in the collaboration between UNIDO, the LKD Facility and EON Reality’s Learn for Life Program, which aims to bring Augmented and Virtual Reality based knowledge transfer to communities that need it the most. The learning concepts behind LKDF Interact can be replicated in other UNIDO projects that focus on industrial skills development, including, but not limited to projects in the heavy duty vehicle industry field.

The 3D simulation content was created by EON Reality Singapore during July / August 2014 and implemented at the Selam VTC during September 2014, along with one demonstration tablet computer. UNIDO provided more tablet computers to the VTC in January 2015, and a second version of the application was supplied by EON in early February 2015. At this stage, students were introduced to the application as part of their formal training programme.


This report provides an overview of an evaluation of LKDF Interact and its use at the Selam Vocational Training centre. The learner surveys were undertaken in early 2015.
2 VR - A Virtual Reality Promise?

VR simulations offer many advantages. One can visualise an entire industrial process, a scientific or engineering principle, test ideas before investment is made in physical construction, as well as recreate long-gone historic and cultural worlds. VR allows for the viewing, and alter, proposed developments before they take place and to visualise technical processes in complete safety – usually impossible in the real world.

Most importantly, VR is also migrating more and more to low end computers – PCs, tablets and cell phones. They can now easily and clearly illustrate how things work, and allow the user (learner) to manipulate the content by taking advantage of VR’s interactivity. In this way, one is able to ‘look’ and ‘see’, and importantly, also ‘do’, in a safe, non-threatening environment.

It is this characteristic that makes VR potentially so powerful in the areas of education, training and learning.

3 VR and learning

Virtual Reality. When we hear these words, we may immediately think of computer or video games, or we may conjure up images of Neo from the 1999 sci-fi classic The Matrix.

In diverse fields ranging from education to manufacturing, VR is becoming a powerful, multifaceted tool that can help with industrial design, employee training, and even getting school and college students interested in science, technology, engineering and mathematics (STEM).

It is generally accepted that about half the students who study STEM subjects in schools and college today end up dropping the subject, with one of the common complaints being that traditional STEM education relies too heavily on theory, and doesn’t provide any inspirational hands-on student experiences. VR-based learning can open up new opportunities for STEM (and other) education, by offering difficult and sometimes mundane content in a new, exciting and engaging way.

In a learning context, VR can be defined as “a mode of interaction between the learner and a computer-generated environment, in which the learner is able to”:

1. View, as well as manipulate virtual objects in a manner similar to what he or she would do in a real environment (interactivity)
2. Heighten the use of multi-sensory, multi-perceptual and multi-dimensional capabilities (visual, sound, etc.) in order to increase their understanding and learning (Fallman, 20031; Osberg2).

These two traits, the ability to interact with virtual objects in a natural way, and the heightened use of multi-sensory, multi-perceptual operation by the learner, are what makes VR a powerful tool for learning. According to Fallman, VR can be used to “facilitate an interaction style of learning which stimulates, motivates and enhances student understanding of learning events” and particularly in those “areas in which uses of traditional methods of teaching have been either inappropriate, or inadequate”.

The levels of learner participation within the virtual environments and the extent to which these experiences will improve learning are key aspects that determine whether VR has real benefits for education.

Osberg (1992) envisaged that “the fusion of computers and telecommunications would lead to the development of highly realistic virtual environments that would be collaborative and interactive”. His prediction has become so true today, through the convergence of internet and visual / 3D technologies.

Aside from secondary education, another area where the use of VR is increasing exponentially is in the area of assembly and maintenance training. Virtual reality allows instructors to deliver complex information in a visually attractive and informative way, whilst at the same time, exposing trainees to real-life (and potentially dangerous) situations, but with little, or no risk – to themselves, nor to the equipment that they are “working” with.

On-the-job maintenance procedures are also being supplemented through augmented reality, where step-wise a maintenance procedure is shown to the technician in real time, either through eye-wear, or more commonly, displayed on a tablet or phone.

3.1 Improved Learning Methods - The Need for Fundamental Change

The need for fundamental change in learning is amplified by the recent emergence of findings in the field of neurological science, which provides insights that challenge conventional educational beliefs and models, especially as entrenched in the current school ‘factory model’.

It follows that modern learning should move from the memorisation of facts to the acquisition of cognitive skills – thinking, learning, and reasoning. The mind recalls best with a context, a global understanding and a complete picture to remember.

The variety of ways in which information is stored and retrieved indicates that our focus should move on from a simple concept of ‘memory’ to “which kind of memory and how it can be retrieved”.

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Current ‘show-and-tell’ teaching methods do not take into account the strengths and weaknesses of the crucially important working memory. The visio-spatial sketchpad and the phonological loop can each hold limited numbers of ‘chunks’ of information (7 ± 2).

‘Show-and-tell’ teaching methods inevitably overload the phonological loop, whilst under-utilising the visio-spatial sketchpad.

This is important, especially as the visio-spatial sketchpad is by far the senior partner. Language has been acquired in the last few ten thousands of years, whereas vision has been, and remains man’s (and other primates’) primary sense for over 60 million years.

To recap:
- ‘Show-and-tell’ teaching methods inevitably overload the phonological loop (new and weak), whilst under-utilising the visio-spatial sketchpad (ancient and powerful)
- As the working of the mind is inherently based on pseudo-3D images, the role of VR in the true learning process is now becoming clearer.

4 VR – an African perspective

Over the past 20 years, we have seen an expanding awareness of the potential impact of general ICT (Information and Communication Technologies) in the promotion of economic growth in Africa. Much of the focus however was expanding the PC and internet connectivity base, content was often something that would follow, in time.

The importance of access to (good, local) content is now being recognised more and more, however, by default, 1st world content remains the norm, delivered via the internet, or DVD. Appropriate content however is crucial in the drive to harness ICT’s for development.

Appropriate content means that it should be locally relevant, locally context specific and where possible, in the home language of the recipient. By ignoring this need, we are simply replicating digitally some of the same education mistakes that have been experienced over the past 150 years in the less-developed parts of the world, not only Africa.

When considering VR as a content class, does the technology have a particular role to play in Africa and other developing countries of the world?

Until recently, outside the realm of universities, VR was confined to specialised (and expensive) fields, such as defence, industrial and energy resources, using high-end graphic computers and associated with costly peripherals such as gloves, stereoscopic glasses and head-mounted displays, or large, full scale 3 or 4 walled display systems. VR’s relevance to Africa was minimal.
Because of recent advances in PC, tablet, smartphone and internet technologies VR, in the form of interactive 3D visual simulations, is now more readily available and accessible to a vast number of learners and other communities of users.

As such, VR and 3D applications can play a tremendous role in the development of human capital across Africa. VR offers completely new ways to visually communicate ideas, skills and knowledge.

There are two other aspects however that make VR so relevant to addressing the needs of Africa. As a visual communication mechanism, it also overcomes:

- **Barrier 1 - Literacy:** VR offers an excellent way to overcome literacy issues that are often experienced in education and training. Due to poor education systems, so many people (and especially in rural areas) are to all intents and purposes, functionally illiterate, and especially in the European languages – yet we still insist on use text (European) to transfer knowledge.

- **Barrier 2 - Language:** So much education and training is undertaken in so-called European languages, which tends not to be the home language of recipient across Africa. This is an immediate and artificial barrier to learning and knowledge transfer.

*Visually facilitating the transfer of context-specific knowledge thereby overcomes all of the traditional verbal and written barriers to communication.*

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5 “LKDF Interact” Impact Assessment - Survey Methodology

5.1 Survey objectives

To assess:

a. Does the content convey a better understanding of the topic
b. The extent to which the learner comprehends the topic
c. Does the VR experience support the application of new knowledge learnt
d. The extent of learning retention
e. Other motivational factors
f. How the 3D application was used in the classroom
g. The extent to which suggestions for improvements were responded to timeously, or at all.
h. Learner profiles (educational level, age, gender, computer literacy etc.).

Data was obtained through the use of on-site questionnaire surveys, conducted at the Selam College in early February with 20 learners, as well as two and trainers (informally, due to time constraints).

The surveys were conducted at Selam Vocational College by Henok Workye – in one group session with learners who had prior knowledge, and experience in the use of LKDF Interact.

The survey questions were presented to the group in Amharic, though the learners decided that they would complete the questionnaire in English.

Data analysis was undertaken by the Naledi3d Factory in Pretoria / Tshwane with the results and outcomes reported herein, as follows.

For reference purposes, as well as for any required validation of the following sections, the original survey sheets, as completed by the students, together with the summary spreadsheet are available on the Naledi3d’s web site. www.naledi3d.com

Henok Workye. An ICT specialist with UNESCO-IICBA, an educational support agency based on the UNECA campus in Addis Ababa. Mr Workye has previously worked with the Naledi3d Factory on three UNESCO-IICBA VR projects (including HIV-AIDS) and is familiar with Virtual Reality as a learning tool, its use is local Ethiopian communities, as well as the translation of VR material into the Amharic language.
6.1 **SECTION A: Pre VR session questions**

1. **How confident are you about:**
   - 1a. Overall Mobile learning experience  
     SD = 1.70  
   - 1b. Engine component identification  
     SD = 1.70  
   - 1c. Engine maintenance issues and solutions  
     SD = 1.95

   While the possible responses could have ranged from 1 and 5, all students responded with either a 1 (very confident) or 2 (confident) - with a slightly lower confidence with engine maintenance issues (1c).

   N = 20; Standard deviations: 1a = 1.70; 1b = 1.70; 1c = 1.95

2. **How did you expect that the VR lesson would help you?**
   - 1 - I will learn faster  
   - 2 - I will learn at the same pace  
   - 3 - It will take longer because I don’t use a computer

   15 students expected to learn faster, 3 expected no change, and 2 expected to take longer. They were also students who said they haven’t used a tablet before.

   N = 20

3. **Have you ever used a tablet before? (Yes / no)**

   The majority, 13 had never used a tablet before (7 had). This was interesting, as the inverse was found in the following question.

   N = 20

3a. **Have you ever used computer-based visual learning materials before? (Yes / no)**

   The minority, 3, had never been exposed to computer based learning before, with 17 having worked with computer based learning material previously. This implies that their exposure was PC based, not tablet, and from the next question, mainly facilitator driven.

   N = 20
6.2 SECTION B: Post VR session questions

1. What was the most important thing you learned about in each of the following:

1a. Overall Mobile VR Learning Experience
   Overall the feedback pointed to a good and enjoyable experience that made the learning interesting, and easier to understand (17 responses). One learner suggested the need for a help manual to provide some guidance and one said that it was interesting, like doing a practical.

1b. Engine component identification
   Nearly all the students (18) indicated that this was a good, and easy way to identify automotive parts and that it made the learning process faster. Two asked for additional video material to be inserted into the app. and one indicated that the time given for parts identification was too short.
   Note. The 30 second timer restriction was removed in the February 2015 release.

1c. Engine maintenance issues and solutions
   Overall, students thought that this was a good tool to help learn this topic (17) and that the app made the material easier to understand. One said it took longer (they also had never used a tablet before).

2a. Did the VR lesson help you to learn and understand more easily? (Yes / no)
   The result was a unanimous “YES” from all 20 students.

2b. Did you enjoy the VR lesson more than your normal lessons? (Yes / no)
   The result was a unanimous “YES” from all 20 students.
3. **Why do you think that this VR lesson was different from your normal lessons?**

   All 20 students said that the App made the subject easier to understand, speed up the learning process; and that the app was also much more fun to use than traditional text-based materials. 7 referred to it being faster, while 14 referred to it being easier to understand (compared to lectures and books).

4. **Are there any parts of the VR learning material that you had difficulty with? (y/n)**

   **If yes, what did you have difficulty with?**
   Problems identified basically relate to a lack of, or no experience using tablets.
   Several students had difficulty using the tablet itself suggesting that they found the touch-screen and gestural components hard to use and that it needs practice to get used to it.

5. **Did each VR unit in the app give you enough time to find the engine components? (y/n)**

5a. **Indicate which areas gave you too little time**

   4. In general through the App
   5. In the component section
   6. In the maintenance section

   75% of the students who said they had difficulties, had problems in the second section (components, and which related to time restraints)

6. **If you could, would you change or improve anything in the VR App.?**

   The consensus (13 responses) is that the app should be expanded to cover all the other vehicle systems.

   Criticism (4 responses) was levelled at the short period of time that the user has to find and click on the various components.
6.3  SECTION C: About the VR lesson

1. To what extent do you agree with the following descriptions of the VR lesson

   1. The computer visuals make the learning easier
      \[N = 20; \text{mean} = 1.40; \text{St. Dev.} = 0.58\]
   2. I understand better with the computer visuals
      \[N = 20; \text{mean} = 1.65; \text{St. Dev.} = 0.91\]
   3. I understand better without the computer visuals
      \[N = 20; \text{mean} = 3.00; \text{St. Dev.} = 1.34\]
   4. It is the teacher’s explanation which makes me understand
      \[N = 18; \text{mean} = 2.28; \text{St. Dev.} = 0.87\]
   5. The computer visuals make the learning more enjoyable
      \[N = 20; \text{mean} = 1.40; \text{St. Dev.} = 0.97\]
   6. The computer visuals complicate the learning process
      \[N = 20; \text{mean} = 2.10; \text{St. Dev.} = 1.34\]
   7. The computer visuals help me to remember what I have learnt
      \[N = 20; \text{mean} = 1.55; \text{St. Dev.} = 1.20\]
   8. This VR session cannot help me revise the topic
      \[N = 20; \text{mean} = 4.30; \text{St. Dev.} = 1.10\]
   9. This VR session fits well with the rest of my lessons
      \[N = 18; \text{mean} = 2.00; \text{St. Dev.} = 1.41\]
  10. Given the opportunity, I would like to have another VR lesson
      \[N = 20; \text{mean} = 1.40; \text{St. Dev.} = 0.92\]
  11. It would help if the on-screen instructions were in Amharic
      \[N = 20; \text{mean} = 2.65; \text{St. Dev.} = 1.65\]

   1 Very confident; 2 Confident; 3 Some Confidence; 4 little confidence; 5 no confidence;

   The outcomes of these questions quantify and support the general statements made previously. For example, the learning is **easier** (mean 1.40, standard deviation = 0.58); **understand better** (mean 1.65, standard deviation = 0.91); **more enjoyable** (mean 1.40, standard deviation = 0.97); and supports memory retention, remembering better (mean 1.40, standard deviation = 0.92).

   A good test of comprehension is to add some negative questions (3,4,8) and in this case, he responses to these questions were lower, for example question 8, where the response reflected accordingly (mean 4.3 (little to no confidence), standard deviation = 1.41).

   The language issue was divided, with 60% of the students saying they agree and 40% not seeing this as an issue.

2. What is your overall rating of this VR lesson?

   1. Excellent
   2. Good
   3. Fair
   4. Poor
   5. Very Poor
3. How confident are you about the learning and new skills that you have received in this VR lesson?

1 - Very confident  
2 - Confident  
3 - Some confidence  
4 - Little confidence  
5 - No confidence

15 students were very confident, the remaining 5 were confident.

4. Do you have any final comments that you would like to make?

All students are basically saying the same thing, they want more interactive mobile content, most want it in their language, and they want a personal experience, not group sharing of a few tablets.

6.4 SECTION D: About Yourself

1. Age

1. 11 - 14  
2. 15 - 19  
3. 20 - 24  
4. 25 - 35  
5. Over 35

2. Sex

1 - Female  
2 – Male

3. Location

1 - Rural community or village  
2. Township  
3. Town or City

14 students came from an urban areas. The remaining 6 came from rural communities.
7.1 Introduction

LKDF INTERACT was developed by EON Reality (Singapore) for evaluation by UNIDO and the Selam Vocational Training Centre, in September 2014, and an updated version 2 in February 2015.

The current version of the LKDF INTERACT EON-UNIDO mobile application (the App) is freely available for download from the Google Play store. It is optimised for use on standard sized Android tablets, running in landscape mode.

As of February 2015, the only available simulation in the App. covers diesel engine operation. However, provision has also been made in the menu system for the addition of another eleven modules that relate to automotive components.

The aim of the App (as it currently configured) therefore aims to teach learners about the location of different key components of a standard diesel engine.

7.2 Basic functionality

The learner is presented with ten different challenges that require the student to locate certain engine components within a specified number of seconds - by touching those components on the screen.

7.3 Detailed operation steps

1. The learner selects an unknown task from a list of ten options

2. The screen opposite appears, listing the components that the user must identify in order to complete this ‘mission’, as it is called.

3. The learner presses the PLAY button to start the simulation.

The AR Marker image shown opposite appears on the screen, asking the learner to aim the tablet’s camera at the AR marker. This marker can be printed onto an A4 piece of paper or displayed on a computer screen.

The moment the camera has locked onto the marker, a 3D model of the diesel engine appears on the screen.
4. The model can be rotated by swiping a finger across the screen horizontally from left to right and vice-versa. The parts that the user must touch are outlined in blue on the model itself.

5. Every part that the learner identifies correctly now appears as outlined in orange, together with its associated part name, now positioned over the part.

6. Once the learner has identified all the parts, a **message of congratulations** appears on the screen and the task is marked as completed in the relevant sub-menu.

   If the user does not succeed in identifying ALL the parts correctly, a **‘mission failed’** message appears

   In version 1, the learner had to touch the return button, re-start the simulation and try again.

   In the newer version 2, this was corrected with a Reset button which allows the learner to go back to the start, without having to re-load the Application.

### 7.4 LKDF INTERACT: Some General Observations

*It is important to note that the LKDF Interact Mobile Application was an internal pilot application; and as such, is not intended for broad use outside the ambit of the LKDF project.*

1. The 3D model used in the application is a very detailed, accurate representation of a diesel engine

2. This is a great way to explore the inner workings of the engine. The transparency actually invites the user to explore the engine further.

3. One question arises around whether using the AR marker to start the simulation in this case is really necessary. Whist demonstrating the potential for AR to trigger events, in this case, it would be more useful to have a ‘library’ of simulations and to integrate full AR at a later stage when it’s use is justified, for example, when pointing the camera at a real engine to load the relevant model and its data into the App

   In practice, it is also quite a challenge to keep the camera aligned with the marker to actually use the Application.
4. Version 2 of the app has a much more robust marker acquisition mechanism that makes a big difference. We also found that holding the tablet more or less perpendicular to an A4 sized copy of the marker (both on a table top) at a distance of approximately 20cm, provides the most comfortable seated arrangement.

Ideally however, if the marker is used to trigger the Application, one would preferably want to pick up the marker and “lock” into it, then be able to move the tablet around whilst using the application itself.

5. It would be useful to have an on-screen list of parts to be able to identify beforehand what one has to find, without having to memorise the list up front

6. The model can only be rotated horizontally. It would be useful if one could also rotate the model vertically as well in order to enhance the VR and interactive experience.

7.5 Response to feedback given by Selam

Following the initial implementation at the college in September 2014, feedback was given during September and October to the development team regarding areas that could be improved, as follows:

1. The issue of using a overhead projector with the tablet computers
   *This should not be a problem, with the appropriate cables*

2. Retry time – could be extended from 25 to 60 seconds
   *The timer has been removed in its entirety in version 2*

3. Selam expressed the need for several other engines to be included
   *This can be done as a future phase of the project*

4. Selam expressed the need for the demonstration of assembly / disassembly
   *This can be done as a future phase of the project*

5. Implement a “Replay” button without having to exit and reload the application
   *In version 2, a 'reset' button was added to reload the “mission” easily (Return)*

6. Fix Technical term errors – for example, Bole for Bore
   *Still to be fixed*

On December 2nd, two further issues were identified and communicated back to the development team:
7. “To create the virtual reality for the four stroke cycle engine, it is essential to add a SOUND on each cycle especially during COMBUSTION”. No sounds added (“like the jet engine that you had demonstrated for us here at Selam)” 

Sound has been added

8. “After combustion and during the Exhaustion cycle the smoke disappears without going through the Exhaust valve. Can it be directed through the Exhaust Valve and ultimately to the exhaust pipe? “See example at http://www.animatedengines.com/otto.html

Still to be attended to
8 LKDF Interact: Interpretation, feedback and conclusions

8.1 Student Feedback - overview
Most of the findings are covered in the previous section, where comments have been added to each of the individual questions.

In summary, all of the twenty students surveyed expressed mainly positives’ about LKDF Interact and from this study, the principle of the use of 3D and interactive 3d in technical training at the artisan level is proven.

This conclusion does however come from a small sample, however, the number of artisan students in Africa who have been exposed to 3D technologies in the learning environment is also small.

To the knowledge of the authors, Selam is the first TVET College in Africa where the students have been actively exposed to the potential for 3D training, and also used the material.

Most of the negative feedback focused on:
1. Around the time required to identify components (which was fixed in version 2);
2. The lack of tablets that would be required for a personal student experience
3. Most commonly, students identified the lack of other, similar 3D material in other learning areas.

8.2 Instructor feedback
Following the student session, two instructors (Ms. Simret ?, coordinator, Auto mechanics Department, and Mr. Henok ??) were informally interviewed to solicit their feedback.

1. How useful did you find the VR tool?
   - Both found the VR tool to be more systematic (and useful) for the instructors to teach with, compared to more conventional teaching methods.
   - Both found that the students were more interested, and active in the classroom, when they were using LKDF Interact.
   - They believe that the students can also use this tool for self-learning and practice as much as they want, and in many ways, it is better than practicing on the actual engines. In this way, there is no risk of damaging items, harming themselves, and there isn’t the usual cost overheads (gas, as well as electricity).

2. Are there any components that need corrections, in your opinion?
   - There is an exercise where it asks the student to “Identify at which stroke the engine stops”. The graphics is not very clear and it is difficult for the user to identify the specific stroke.
   - Some automotive terms have to be corrected. The correct terms were fed back to the development team (to the person who demonstrated the application to them in September).
• The Application covers the diesel engines, but they would like more topics, such as vehicle electronics to be also added. (Note, this was also fed back by most students as well).

3. Do you have any messages/comments that you want to send?
• Computer resources: the Department currently has 25 tablets for the students to use, but, to be able to enable the students to have a personal experience, more tablets are required.

To maximise the benefits of LKDF Interact (and other VR material), each student should be able to work with one tablet.

8.3 Interpretation – informal feedback
1. Informal feedback on LKDF Interact from Selam VTC from the lectureing staff was in the main qualitative, and based on comments from Tamirat Tadesse, a facilitator at the Selam Vocational Training Centre. These were made directly to UNIDO, and summarised by Virpi Stucki (UNIDO) on September 24th 2014:
• Regarding cost-effectiveness: “Tamirat mentions that “teaching time can be saved”. As a result, one could envisage that a curricula could be shortened leading to costs savings.”
• Regarding attractiveness of skills training: “Tamirat mentions that the application has made “learning process by far simple and amazingly impressive”. Since the TVET field is suffering from an “image problem” in many parts of the word, including Africa, I see that using 3D solutions eventually can change that image. Hence attracting students to the TVET sector might be easier in the future.”
• Regarding scalability: “We want to introduce the LKDF Interact Diesel Engine as a learning aid in the future projects, e.g. in Morocco and in Zambia, where we have a need to compress the curricula in order to better the cost-benefit ratio”.

2. Feedback from Tamirat Tadesse directly to EON Reality (September 2014) included the following comments:
• “The mobile application is very positive and the technology had made the teaching and learning process by far simple and amazingly impressive”
• “In addition, the effort needed to explain a specific topic or part on the engine can be viewed and understanding time can be shortened significantly”
• “Hence, teaching time can be saved and it has enhanced the colour of teaching to be beautiful compared to the traditional teaching methods”
• “Moreover, staff that may have less capacity to give an in-depth explanation of parts may have a greater opportunity to teach much better than before with less burden and stress”
8.4 Are the findings at Selam Vocational Centre new? School surveys in Uganda and South Africa, 2004\textsuperscript{6}

In 2004, similar field surveys were undertaken in Uganda and South Africa, focusing on school students and teachers. The surveys included over 280 students and 32 teachers.

The field surveys, undertaken by the Naledi3d Factory, in collaboration with UNESCO, the UNESCO National Commission for Uganda (Ms Anastasia Nakkazi, Secretary-General, and Mr Martin Nsubuga); UNISA (University of South Africa, Dr Rita Kizito, Learning Developer, UNISA, Dr R.S. Day, ICT Executive, UNISA and Jacques Hugo of Usability Sciences). The Ugandan studies were co-ordinated by the Uganda National Curriculum Development Centre (Victoria Kisaakye), Kyambogo University (Professor Albert Lutalo-Bosa, Principal), and the National UNESCO IIP Committee (Professor Paul Mugambi).

Even though this study was undertaken ten years ago, used different 3D material as a basis for the assessment (mainly life skills simulations, such as basic hygiene) and were in different countries, the results are surprisingly similar.

8.5 Uganda and South Africa: Students’ Rating of the VR Lesson

The students felt that the computer visuals made the learning easier, the topic easier to understand, learning more enjoyable, learning easier to remember, fitted in well with other lessons and helps with the revision of topics. In addition, nearly 95% of the students rated the VR lesson as good to excellent.

8.6 Uganda and South Africa: Teachers’ Rating of the VR Lesson

Overall, the teachers felt confident that VR was an effective teaching tool that could be integrated into courses. All teachers believed VR offered a good way of teaching the topics concerned.

There was a strong correlation between teachers and students in that both groups agreed that the VR lessons were enjoyable, easy to integrate into courses and could help with the revision of topics. 74% of the students felt confident to very confident in the learning received. Both groups also agreed that the software could be used in more than one course. 50% of the students learnt things about more than one topic.

Some were concerned that software / hardware costs, and lesson preparation might be of concern, due to a shortage of computers in schools and the cost of rectifying the problem.

As to lesson preparation, one can expect an initial learning curve for teachers as they adopt to VR as a new teaching tool (experience in previous projects in Uganda with the UNESCO National Commission show that there are ways to overcome this barrier).

## Conclusion

In conclusion, the overall outcome of this survey at the Volvo Selam Vocational Training Centre can be reduced to a very few words:

**Firstly, all the responses from the students were very positive, they learn faster, learn more, and at a lower cost.**

**Secondly, ALL the students are saying the same thing, with no dissent, - we want more 3D content, some of us want it in our language, and we want a personal experience, not group sharing of the few tablets that we have.**
Annexure 1: the Naledi3d Factory

The Naledi3d Factory, located at the Innovation Hub in Pretoria creates 3D visual educational content, usually based on Virtual Reality (VR) or animation. VR allows us to create material that is BOTH content as well as context rich, in realistic and stimulating three-dimensional environments.

Today, we can bring this powerful visual communication medium to modern PCs and to many communities.

In Africa, where poor literacy skills and language barriers pose huge challenges to learning and skills development, VR comes into its own. It’s intensely visual nature transcends literacy and language barriers by showing as opposed to telling. VR has a distinct and powerful edge over other more traditional approaches which ignore the visual nature of our human brains.

Our interactive3d learning objects (self-contained, “localisable” visual learning) takes this to an even higher level.

VR appeals to our most powerful visual sense. Beyond learning, VR-based simulations can provide a great way to promote cultural heritage, products, new technologies and proposed building developments to stakeholders.

At the Naledi3d Factory, we have successfully used VR to communicate concepts and practices in a wide range of disciplines, including industrial training and safety awareness, heritage, new technology concepts, town planning, farming, as well as health awareness, sanitation and water issues.

Our partners include UNESCO (with whom we have worked with for over nine years on many projects including rural hygiene; Malaria; HIV/AIDS awareness with Ethiopian educators and employment awareness – piloted in Alexandra, Johannesburg; the SA Dept of Labour (lathe and milling training simulator); the WK Kellogg Foundation, World Links Zimbabwe, with whom we supported emerging farmers in Zimbabwe on agricultural issues; and SAFIPA (water conservation).

We have worked with organisations such as ESKOM (sustainable energy technologies); CSIR, Rand Water (industrial training), IDT (development) and SANEDI (energy); as well as the private sector including AngloGold Ashanti, where we have addressed a wide range of mine safety issues.

We have close ties with Finland, Sweden, the USA and UK, but focus our efforts in Africa and have worked with partners in Ethiopia, Kenya, Rwanda, Uganda, Mozambique, Sudan, Senegal, Zimbabwe and South Africa itself.

Over and above our work in VR, we also:

- Create high-impact 3D videos, a truly powerful way to launch a new product or a new infrastructure project
- Create E-learning material – where there’s huge potential for combining 3D with traditional e-learning content

The Naledi3d Factory:

- World Summit Awards (2009) Achieved “honourable mention” for the work with farmers in Zimbabwe (selected from over 20 000 project nominations, from 154 countries
- African ICT Achievers Awards The most Innovative ICT Company in Africa (2005 Finalist)
- the Naledi3d Factory A Technology Top 100 Company –2005
- Business Day, 2003 “One of South Africa’s most innovative companies”