EDUVENTURES WEBEXPEDITION

AN INTERACTIVE QUALIFYING PROJECT REPORT

WORCESTER POLYTECHNIC INSTITUTE

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ABSTRACT

This project, sponsored by EduVentures and the National Museum of Namibia, sought to increase Namibian secondary students' awareness of biodiversity by creating and deploying a computer game called *WebExpedition*. We received input from teachers and students to optimize the game's usefulness and effectiveness, and performed trial runs with Namibian students. The game teaches students about scientific classification of organisms, and allows students to connect animals and plants to their habitats in Namibia.

ACKNOWLEDGEMENTS

AUTHORSHIP

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EXECUTIVE SUMMARY

The biodiversity of the world is an incredible natural resource and the backbone of African economies (United Nations Environment Programme, & AMCEN Secretariat, 2002). However, it is being depleted at an alarming rate. EduVentures is an organization that helps to combat this issue by increasing environmental awareness among Namibian secondary school students. The active learning opportunities provided by the organization greatly affect the students' knowledge and interest in the environment. However, the number of students who can participate in the program is limited. As a result, EduVentures initiated a project to create an interactive computer game called *WebExpedition* to help propagate environmental awareness to a much broader range of Namibian students.

The objectives of this project were to create an interactive computer game that:

- Can be easily distributed via the web;
- Can be used in classrooms where computers are available to students;
- Can supplement teachers' syllabi while conforming to Namibian curriculum standards;
- Can effectively teach and excite students about biodiversity and the environment in which they live.

BACKGROUND

Modern educational trends include an increasing emphasis on scientific education and scientific literacy. One of the practical applications of scientific literacy is that persons who are educated about the environment are more likely to make smart environmental decisions (Moulton & Sanderson, 1999). Cognitive science has revealed that many traditional teaching methods such as lectures, reading, and regimented experiments are less effective than newer participatory and experiential techniques (Bransford & Donovan, 2005). Computers and interactive learning games present experiential methods that can be relatively easy to distribute and use. In particular, educational games can create a sense of fun that allows users to generate an ownership and self-motivation to their own learning (Klopfer, 2007).

The Ministry of Education of Namibia emphasizes a more learner-centered approach to education (Ministry of Education, 2005). However, many teachers in secondary schools struggle with these new methods. As part of the effort to modernize education, the government of Namibia and non-governmental organizations such as SchoolNet are providing schools with computers and access to the internet. The biology curriculum mandated by the Ministry of Education for secondary schools includes teaching the ability to identify and classify organisms

(Ministry of Education, 2005). This provides opportunities to blend more modern techniques into the curriculum through easy-to distribute computer-based games that can teach students about the biodiversity of their country.

METHODOLOGY

In order to create an effective game, we first gathered information about the needs of EduVentures, secondary school teachers and students through

- Interviews with EduVentures staff;
- Interviews with secondary school teachers at EduVentures' partner schools;
- Survey of students of the teachers interviewed;
- Focus groups with secondary school students and teachers at EduVentures' partner schools.

We created a game called *WebExpedition* based on this information, and have made suggestions for its use. Using the development software Adobe Flash, we constructed a game that can be played online via a web portal or downloaded from a website and played as a stand-alone application. The game can also be distributed on CDs. To accompany these options, we created suggestions for how *WebExpedition* can be used as a supplemental classroom activity. EduVentures also received a design document and owners' manual for the game.

We ensured the functionality of the game through beta testing with a class of grade nine students. To demonstrate the game's effectiveness, we held trial runs of the game with small groups of student volunteers from the Polytechnic of Namibia. To show that learning objectives have been met, the game monitored whether students answered questions correctly throughout play, and how often the students asked for hints. The students were presented with a survey after playing the game called the EGameFlow scale, a scale for measuring students' enjoyment and the effectiveness of learning games (Fu, 2009). To encourage teacher use of the game, we met with teachers and provided them with the software to run the game. The outcome was a well-documented, effective, and easy to use educational game that can teach students about biodiversity in Namibia.

The game play of *WebExpedition* simulates the EduVentures experience. *WebExpedition* starts the user at the National Museum of Namibia where EduVentures is located. From the museum, users can view a map and travel to different sites around Namibia. Users go on virtual expeditions, traveling to areas with interesting biodiversity, and collecting samples or photos of plant and animal species such as spiders, scorpions, mammals, and plants. When users collect samples, they are presented with a challenge to biologically classify them. If the users

successfully classify a sample, it will be added to their collection, which is stored for them at the museum.

RESULTS AND ANALYSIS

The results from our methods were split up into five different sections:

1. Determining the status of biodiversity education in Namibia
2. Determining content of the game
3. Development of the game
4. Implementing the game into the classroom
5. Evaluation of the game

We found that environmental issues and biodiversity are taught in the Namibian curriculum, but that secondary school students are still isolated from their natural environment, and are naïve about it. We developed the *WebExpedition* game by including game content ideas obtained from teachers and EduVentures staff. From interviews with experts at the museum, professors at the Polytechnic of Namibia and researchers at the National Botanical Research Institute of Namibia we selected five plants and five animals for each of Namibia's four biomes to include in the game. Once the game was playable, we tested it on students to evaluate their progression in the game and any problems that arose while they were playing. Through several beta tests with secondary school and first year Polytechnic of Namibia students, we found that students enjoyed playing EduVentures *WebExpedition* and were learning about Namibian biodiversity from it.

CONCLUSIONS AND RECOMMENDATIONS

The teachers that we worked with were very excited to have access to an educational game that would teach students about biodiversity. It proved to be a valuable educational game in which teachers and students were interested. The game can be included as an activity in the secondary school biology curriculum in Namibian schools and as an educational game that students can use on their own. Inclusion of the game in the classroom will help to introduce the game to the students and help promote future use. We have concluded that future use of *WebExpedition* will be enhanced if the game is updated with new and interesting content. Additional content ideas for the game include adding environmental issues that would make the students more aware of the problems facing their country's biomes. This would help to ensure that the students are learning about the environmental issues today in order to become well-educated environmental leaders in the future.

1 INTRODUCTION

People who are properly educated about the environment are more likely to make decisions that benefit their community and to be active in the preservation of the environment. Those who do not receive this education are at risk of not gaining the knowledge necessary to sustain the environment or make informed and accountable environmental decisions. Persons who have no knowledge of their environment may have no urge to protect or conserve it. Environmental issues go far beyond the well-known topics such as alternative energy, climate change, and green movements. Biodiversity conservation, environmental activism, and desertification are a few examples of the topics that people need to be educated about to help in preserving the world's ecosystems. With increasing environmental issues in many countries, it is becoming critical to disseminate scientific knowledge to more people (Batley & Wenning, 2007). Through the creation of alternative and engaging learning experiences, society as a whole can become more aware and interested in the environmental issues affecting the world today and those to come in the future.

Alternative learning experiences for secondary school students in Namibia are increasing with help from organizations like EduVentures. The EduVentures program works with the National Museum of Namibia and offers programs for Namibian students to participate in biodiversity research, environmental studies, and data collecting expeditions throughout Namibian ecosystems (Mapfumo & Vollbrect 2008). These learning experiences are being developed in Namibia to teach secondary students about the environment. Gaining knowledge about biodiversity and the environment in an interactive and exciting manner will help these students to become more prepared for their future by enabling them to understand and make informed environmental decisions.

It is challenging to develop new and exciting ways to teach scientific and environmental knowledge and to get secondary school students interested and involved in the subject. Teaching secondary school students about the environment and local biodiversity using an interactive computer game is one newly developed approach. An interactive game allows users to become more involved in the learning through increased participation. However, researchers have been trying to determine whether new technology initiatives provide opportunities that encourage learner-centered education or create disturbances in the learning environment (Chapman & Mahlck, 2004). There have been new creative learning opportunities in educational technology, but educational technology faces limitations based on available

technology and teachers' willingness to implement it. More research is required to determine the most effective ways to communicate with the students (Campbell et al, 2005).

Alternative teaching methods are also an essential part of education for students who are deaf and hearing impaired. It is important to ensure that students with disabilities can learn and benefit from educational games as well. An interactive computer game is a great way to help teach hearing impaired and deaf students about biodiversity and the environment since it can be created to include many visual aids. Since sign language has a significantly different structure than verbal languages, it is often difficult for students with hearing impairments to read complex instructions or for teachers to communicate complex ideas. Teachers of students with hearing impairments use alternative methods, especially visual and interactive methods, to help communicate the material being taught, however during a typical lecture it is difficult to execute such strategies because the teacher must use his or her hands to speak. An interactive computer game made with considerations for the deaf allows the students to see and experience concepts, and gives the teacher an alternative method for teaching the students.

The effectiveness of implementing modern learner-centered education in the Namibian school system has yet to be fully researched. Since only a select group of students can participate in the EduVentures program, EduVentures has determined that an interactive computer-based learning game will help to extend knowledge about the environment to more students, and that is exactly what our project team has set out to create.

Our project team from Worcester Polytechnic Institute has developed a game called *WebExpedition*. Namibian secondary students now have another opportunity to learn and become more interested about their country's natural environment through the use of a fun and exciting interactive web-game. In order to develop the game content and structure, given the limitations and specific target audience, data were collected by observing classroom experiences and conducting interviews with students, teachers, and researchers in relevant fields. The game had fit well with the current curriculum, teaching styles, and student interests in the Namibian school system. By conducting individual interviews and focus groups, we gained a better understanding of how the game could be implemented, and created the game to most effectively reach students. We made sure that the game was functional by conducting tests with students, and improving the game based on their input. After making enhancements to the game based on our initial testing, its effectiveness was measured to ensure that students were learning about biodiversity while having fun. *WebExpedition* proved to be a successful tool for teaching secondary school students in Namibia about their country's environment and biodiversity.

2 LITERATURE REVIEW

The creation of educational computer games in Namibia encompasses many different topics. Our design must take into account the educational theories surrounding the topic to be taught: scientific and environmental education. The pedagogy of these disciplines should be employed, as well as pedagogical techniques that are integral to the effectiveness of educational games. In addition, the game must be tailored to the environment in which it will be used, namely secondary school classrooms in Namibia. It will also be accustomed to the needs and resources of these schools, as well as the curriculum that teachers follow. This section of our report will discuss educational theories, computer educational games, the Namibian educational system, and our target audience in more detail.

2.1 EDUCATION

Over the past century or so, educational theory has moved the focus of the learning process away from the instructor and towards the learner (Conrad & Donaldson, 2004). Learning has come to be understood as an active process rather than a passive one. Knowledge is now seen by researchers not as something that is static, which is gained simply through the transmission of information, but rather as something that is built uniquely by each learner (Coppola, 2004). Educational styles that are based around this premise are grouped into a learning theory called constructivism. Along with the idea that learning is a constructive process, educational theorists and psychologists like Vigotsky and Piaget have concluded that learning is a social process where knowledge is built as a learning community, not individually (Conrad & Donaldson, 2004). Vigotsky believed that development of knowledge occurs best when the learner is paired with someone more advanced, whether it is a peer or an instructor. On the other hand, Piaget believed that collaborative learning is most effective when peers are at equal levels, but they both emphasize the importance of social interaction as part of the learning process. Teaching strategies based on constructivist theories are becoming ever more present and are changing the way in which education is practiced.

2.1.1 Science Education

There are two main reasons that science education is important. One is the fact that in a society of growing technology and infrastructure, we must ensure that there will be enough people that enter the fields of science to continue developing our technology and progressing our understanding of the world (Shamos, 1995). Science education is necessary not just for

those who will go on to become experts in the field, but everyone in society. The goal of the latter is to achieve what is termed "scientific literacy" among the general population.

Scientific literacy is defined by Hazen (1991) as the scientific knowledge one must possess to properly understand public issues. He argued that, "*doing* science is distinct from *using* science; scientific literacy concerns only the latter" (p. xii). It is important that the general population be scientifically literate because as a whole, they have a significant effect on the directions of technology and public policies (Shamos, 1995). Shamos challenges the idea that universal scientific literacy is achievable. He suggests that instead of trying to achieve a deep understanding of science for the majority of people, it is more important to create an awareness and appreciation for how science is practiced. This has not stopped the major trend in educational policy from including more and more science in curricula at earlier levels.

2.1.2 Environmental Education

In Africa, there is a gap in the local people's knowledge about the environment (United Nations Environment Programme, & AMCEN Secretariat, 2002). In addition, little is known by the general population about the ecological systems and species of Namibia, particularly the knowledge of invertebrates, algae, and fungi. Natural resources are therefore only discovered and exploited commercially, making them susceptible to being overused (Caughley, 1994). Local people, especially the impoverished, need to be taught the long-term benefits of sustainable development and reforestation if the resources on which they rely are not to be decimated (SEEN, 2005). As impoverished populations increase, they deplete natural resources at an enormous rate (Branch et al., 2007). Persons in poverty do not have the resources or knowledge to be concerned about their environments (SEEN, 2005). Without other options, they rely completely on natural resources for food, shelter, and livelihood (United Nations Environment Programme, & AMCEN Secretariat, 2002). These people do not have the time or resources to travel far from their homes to gather firewood, water, and food, and therefore very quickly deplete all resources in their area (SEEN, 2005). In Namibia, it is particularly difficult for women to obtain the resources necessary to carry out their daily lives. Women earn about 25% of what men earn, and yet primarily bear the load of caring for their children. In the Okavango River, for example, women know that fishing with mosquito nets is killing more fish than they catch. They claim to have no choice, as traditional methods are much slower. Situations similar to this one are a significant cause of extinctions, deforestation, and erosion in Namibia.

Science curricula often contain biology and earth science topics. In these classes, knowledge about the environment is imparted to the youth. Young people are made to be

excited about the world they live in, which greatly enhances their interests in conservation. Indeed, informing the public about environmental issues is known to be one of the most effective ways to combat serious environmental problems (Moulton & Sanderson, 1999). When people become educated about science and the environment, it allows them to make prudent environmental decisions.

2.1.3 Pedagogical Techniques

For a long time, science was taught by transferring information to students about scientific theories, concepts, and models by way of lectures, reading, or regimented experiments (Bransford & Donovan, 2005). Learning science meant memorizing the facts and theories of science, the vocabulary involved, and occasionally the following of a step-by-step experiment to draw a predetermined conclusion. Bransford argues that these models for teaching science may allow students to perform calculations and recite facts, but they do not create genuine understanding of any of the concepts. Because of this realization, new learning models have emerged that address this lack of understanding. These models prioritize learning through the inquiry of the student, rather than adding inquiries as a superfluous addition to the learning experience. The identification and understanding of students' preconceptions about a certain topic is also an important method. The instructor can aid students in building knowledge based on their preconceptions by correcting misconceptions and extending existing understanding.

2.1.4 Lesson Plans

A lesson plan is a solid list of tasks and events to be executed in the period of one lesson. Gagné et al. (1992) have described essential steps in the creation of lesson plans. The first task is to determine the objectives of the lesson. These objectives have to be converted into "performance objectives," which have measurable outcomes. The type of knowledge learned must be determined: discrimination, concepts, rules, problem solving, cognitive strategies, verbal information, motor skill, or attitude changes. Of particular interest to our project is attitude, which centers on the way learners choose to behave. Lesson plans that focus on changing attitude should make sure that they also establish respect for the source of the lesson and use vocabulary that is either commonly known or taught within the lesson. During the course of a lesson, nine learning events correspond with cognitive learning processes. These are shown in Table 1. Any lesson, including those that use computer-based educational games, should incorporate components that relate to each event in order to fully engage learners' cognitive learning.

TABLE 1. EVENTS OF INSTRUCTION (GAGNÉ, 1992, P 190)

Learning event	Relation to learning process
1. Gaining attention	Reception of patterns of neural impulses
2. Informing the learner of the objective	Activating a process of executive control
3. Stimulating recall of prerequisite learning	Retrieval of prior learning to working memory
4. Presenting the stimulus material	Emphasizing features for selective perception
5. Providing learning guidance	Semantic encoding; cues for retrieval
6. Eliciting the performance	Activating response organization
7. Providing feedback about performance correctness	Establishing reinforcement
8. Assessing the performance	Activating retrieval; making reinforcement possible
9. Enhancing retention and transfer	Providing cues and strategies for retrieval

2.2 COMPUTERS AS EDUCATIONAL TOOLS

The increasing availability of computers has opened up a new world of possibilities for enriching experience that can be employed effectively for teaching. Eric Klopfer et al. (2009) put it nicely by saying: "… these technologies afford us the ability to convey concepts in new ways that would otherwise not be possible, efficient, or effective, with other instructional methods" (p. 4). The use of computers as educational games has become very popular, and is still rapidly expanding. Additionally, the internet has revolutionized the availability of information and of communication. This has not only increased the collective body of knowledge and information, but it has also spread it to everywhere that the internet reaches. As stated previously, an important aspect of learning is peer communication and social interaction. The internet enables rapid communication among unprecedented numbers of people, and across vast distances.

There has been a fundamental change in how students learn when growing up in an age of internet and computers (Prensky, 2005). The generations of people that have grown up using computers actually think and learn in different ways than those who have not. Prenksy uses the

term "digital native" to describe those who have grown up in the presence of computers and "digital immigrant" to generations that did not grow up with computers, but are now being forced to interact with these tools as they become more and more intertwined into our society.

2.2.1 Educational Tools for Computers

There are many computer tools that can be educational, but the tools that are designed with the intent of interactive education are educational games and online curricula. Computer games come in many different forms and genres and can range from a simple puzzle game to an elaborate 3-D adventure game with a giant world to explore. Any genre of game can be developed into an educational tool. For youth and adolescents the majority of their home computer use is spent playing games (Papastergiou, 2009). This is one of the reasons that games have become popular as educational tools. Computer games as educational tools have not gone without criticism though. Many are not willing to accept games as a valid method of teaching and swear by the more traditional styles of teaching like memorization, recitation, and testing (Prensky, 2005).

The Web-based Inquiry Science Environment [WISE] is an online learning environment that is used in a classroom setting where students work in pairs and work through "modules" that teach about a certain topic in science through inquiry methods (WISE, 2009). Students are presented with questions, and they are guided through the WISE environment by informational content, models, and simulations. The WISE environment encourages reflection and collaboration through the process. Hints are given along the way in the form of questions to guide students and allow them to develop ideas on their own. WISE also incorporates the ability for classrooms from separate schools to communicate through the internet, collaborating, and building off each other's learning and knowledge. WISE is an excellent interactive educational tool that provides an engaging learning environment.

Computer-based education provides new ways of motivating and engaging learners (Prensky, 2005). Moreno-Ger (2008) stated that a successful educational game must contain a balance between fun value and educational content. If the game is not fun enough, then it loses the power to motivate the learner. If there is not enough educational content included, the value of the game as a learning tool diminishes. Prensky (2005) goes as far as saying that the fun factor should be placed at a higher priority than learning. Bizzocchi and Parras (2005) reinforce this point by saying that "Games foster play, which produces a state of flow, which increases motivation, which supports the learning process" (p. 4). This implies that the progression in an educational game starts with play, and learning is a result of this, not the reverse. The concept of flow, originally introduced by Csikszentmihalyi (Kiili, 2005), is brought

up in multiple sources on educational game design. It represents a state in which one is completely absorbed and engaged in an activity. Research has shown that the state of flow influences learning positively. Inducing a state of flow in a user is achieved by providing a constant source of challenges that are difficult enough so that the user is not underwhelmed. As he or she overcomes those challenges, the challenges must be replaced with new ones that increase in difficulty to adapt to the user's increase in skill. The best way to ensure that a game is always challenging enough without being overwhelming, is to make it adaptive in difficulty based on the user's actions.

2.2.2 Pedagogical Techniques in Games

In studying the pedagogy behind educational computer games, it became evident that the main focus in their design is implementation of learner-based, constructivist educational theory, rather than those of direct instruction. A study of 18 educational computer games, which were designed with pedagogical principles in mind, showed that 17 out of 18 games used learner-focused strategies, while only one used a direct instructional approach (Kebritchi et al., 2008). Constructivist educational theory is empowered by the ability to deliver enriching interactive environments and experiences to the user using computer technology (Prensky, 2005). There are a variety of techniques to be used, and the ones chosen should be tailored for the specific educational topic and audience. This is not to say that just one should be selected and used. The methods can be combined and blended.

Experiential learning, or "learning by doing," is a method of learning through active participation of the learner in a process that is grounded in reality (Kebritchi et. al., 2008). In a computer game, the experience of the user will not be "real," but computer simulations, as long as they are grounded in reality, can result in experiences that promote learning (Shaffer, 2006). A relevant example can demonstrate this fact: participants in the EduVentures' program learn about collection methods when they go out into the field and actually collect organisms. This is an example of "real" experience, but if an accurate computer simulation of the collection process were created, the same experiential learning process that happens in the Namibian wilderness could also occur in a computer lab. Experiential learning activities have a defined learning outcome and a mission to be completed (Kebritchi et. al., 2008). Reflection and feedback throughout the process is an important component of experiential learning in order to elicit critical thinking and evaluation in the learner.

Discovery learning is an approach similar to experiential learning, but is focused more on the learners finding knowledge for themselves through experimentation (Prensky, 2005). It is similar to experiential learning in that there is an end objective, often a problem to be solved,

but the path to the solution is not as well defined. The user must seek out pieces of information dispersed throughout the game environment, and form them together toward a solution. This style of learning can be frustrating or confusing for some, especially if there is insufficient guidance and feedback throughout the game. However, too much structure and guidance would restrict the discovery aspect. A careful balance should be formed where the user does not become lost or stuck but also is not being instructed on a one-track path through the game.

Characters within a game can be used very effectively to enhance the learning and game experience (Johnson et al., 2008). Characters that have a specific role of teaching are called pedagogical agents. These characters can aid in things like storytelling, explaining instructions, giving hints, and offering sources of knowledge. The use of pedagogical agents is an effective strategy not just for providing instructions for an educational game, but also as a method of coaching the user through an educational environment in a more personal way than solely with text instruction.

The pedagogical technique of constructivism involves building a concrete product as a method of learning (Papert, 1992). This should not be confused with the educational theory of constructivism, which defines knowledge as something that is constructed rather than received. They are different things, but constructivism could definitely be considered to fall into the category of constructivist learning. Through building a product, the student takes ownership of the product and develops an investment in the process. This investment and ownership greatly enhances the connection that the learner has to the knowledge built through the process.

A style of computer game that is very effective as an educational tool is what Shaffer (2006) calls an "epistemic game." An epistemic game refers to a game where the player takes on the role of an expert in a certain field and therefore gains an understanding of actual ways of knowing, or epistemologies, in that field. This is done by allowing the user to participate in activities in the game that the expert would in real life and, as a result, he or she uses the same methods toward acquisition of knowledge that the experts would. The game "Urban Science" is a simulation game where the player takes on the role of an urban planner and must redesign a mall based on all the considerations that a real urban planner would. The educational goal of the game was to teach ecology in the context of urban development, but social and economic factors were given equal weight in the game. Assessments before and after students played the game showed a great increase in understanding of urban planning and ecology. According to Shaffer, "Before the game, less than 10% of the players could explain what the word ecology meant. After the game, more than 80% could…" (p. 174).

Social interaction is an important part of the learning process, and computer games are an excellent method of creating environments of peer communication and interaction. An example of this principle in action can be seen in the case study of an educational computer game tested with students from several secondary schools in disadvantaged communities in South Africa (Amory & Foko, 2008). It should be noted that the majority of students testing the game were not familiar with the use of computers.

The game played was called *Zadarh*: "a game designed to provide learning resources that address specific misconceptions related to photosynthesis and respiration, evolution, Mendelian genetics and 2D/3D visualization" (Amory & Foko, 2008). Three groups of students tested the game in an individual environment, and while the students enjoyed playing the games, the learning outcomes were less than satisfactory. Students gave correct answers on assessment tests but for the wrong reasons, which indicated a lack of understanding. Another iteration of testing was done, but this time the game was played in pairs. The results improved significantly on assessment tests (see Figure 1). This supports the idea that learning is most effective in an environment where there is peer communication. This study is especially notable in relation to our project because of the similarity in circumstances to those in Namibia concerning computer literacy and cultural environment.
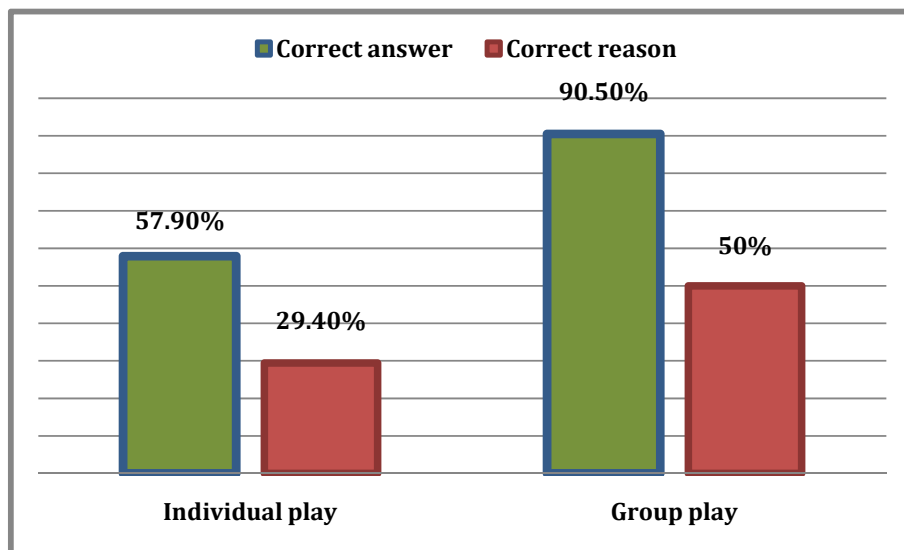
FIGURE 1. ZADARH POST-PLAY ASSESSMENT. SHOWS THE PERCENTAGE OF CORRECTLY ANSWERED QUESTIONS AND THE PERCENTAGE OF CORRECTLY IDENTIFIED REASONS FOR THOSE ANSWERS FOR INDIVIDUAL AND GROUP PLAY CASES (FOKO & AMORY, 2008).

Another important pedagogical technique is the use of feedback and assessment throughout game play. This is one thing that educational computer games can do well (Moreno-Ger, 2008). Although most games are not capable of analyzing qualitative responses from

students, they can easily provide immediate feedback when quantitative, objective responses are involved. Continuous assessment of the learner's progress throughout play not only keeps him or her invested in the outcome but also allows reflection on the understanding of a concept as it forms and develops. Reflection is an important process in allowing students to develop understanding.

2.3 NAMIBIAN EDUCATIONAL SYSTEM

In order to better understand how to create the EduVentures *WebExpedition* game, we looked at the Namibian educational system. The Namibian educational system has changed several times since the country's independence in 1990 (Ministry of Basic Education, Sport and Culture, 2004). For the first decade after Namibia reached independence, the country mainly focused its educational efforts on facilitating access to education for all and encouraging the Namibian people to take part in increasing their knowledge through education. The more recent period of change in the educational system of Namibia has been a major result of the work done by the Republic of Namibia's former President Sam Nujoma (National Planning Commission Secretariat, n.d.). He discussed how he sees the educational system in the future through the national movement entitled *Vision 2030*. One of the major goals of *Vision 2030* is to meet present educational needs and ensure that Namibia has the resources necessary to compete in the changing world of education. In a national educational review carried out by Moritz Rosenmund (2007), the need to educate young students for lifelong learning is a major point of consideration. In his report, he quotes Namibia's national report on education, "Educational content also needs to be aligned with emerging and developing needs of society" (p. 186).

2.3.1 System Structure

According to the Ministry of Basic Education, Sport and Culture (2004), the formal school system in Namibian government schools consists of 12 years of schooling broken down as follows (p. 12):

- 4 years of lower primary, using mother tongue as a medium of instruction;
- 3 years of upper primary, (English as a medium of instruction starts in Grade 4 and goes up to Grade 12);
- 3 years of junior secondary; and,
- 2 years of senior secondary.

The primary target audience for EduVentures is 14-17 year olds, and many of the students in this age range fall into the "Secondary Phase" of schooling as described by the Namibia National Report on Education. This phase is mainly comprised of 8-12th grade students (Ministry of Basic Education, Sport and Culture, 2004). Although the formal education system in Namibia is continuing to advance, the Ministry of Education has identified several goals (p. 14):

- Access to education
- Equity in education
- Quality of education

The structure of Namibia's educational system can be broken down even further. Once a student reaches senior secondary, there are two paths that a student can pursue (National Institute for Educational Development, 2009). There are different syllabi created for Namibia Senior Secondary Certificate for Higher Level and for Namibia Senior Secondary Certificate for Ordinary Level (see Appendix D). Each subject listed in the syllabi is based on various skills:

- Communication skills
- Numeracy skills
- Information skills
- Problem-solving skills
- Self-management and competitive skills
- Social and cooperative skills
- Physical skills
- Work and study skills
- Critical and creative thinking

The Namibian educational system and course syllabi are extremely structured and appear to have no room for allowing curriculum change.

2.3.2 Core Curriculum

In the early 1990s many educational experts argued one of the most common deficiencies in the Namibian school system was that the curriculum for secondary schools was not preparing students for the world of work and for learning life skills such as values, respect, and even common manners (Baine & Mwamwenda, 1994). However, with the new initiative taken by former President Sam Nujoma in *Vision 2030*, the country's curriculum and educational system will be greatly improved through ensuring equal educational opportunities in the public system, and better training methods for teachers (National Planning Commission Secretariat, n.d.). The curriculum will be more focused on preparing students for the rapid change in the

world's economies, as described by Dr. Nujoma, "As required by this Vision, the country will operate a totally integrated, unified, flexible and high quality education and training system, that prepares Namibian learners to take advantage of a rapidly changing global environment, including developments in science and technology" (p. 10).

2.3.3 Teaching Style

Teacher preparation is one of the most important aspects to improving current educational conditions in the Namibian educational system. Teachers are looked upon as "both agents and implementers of change" (Ministry of Basic Education, Sport and Culture, 2004, p. 19). The teaching styles in the Namibian school system vary from school to school, but much of the senior secondary education in southern African countries is "authoritarian, disciplinarian, teacher-dominated, content-oriented and knowledge-based" (Baine & Mwamwenda, 1994, p. 116). This is how the school system in Southern Africa operated soon after independence. Teachers were accustomed to disciplinarian practices because of the ways that they were taught—further emphasizing the need for Dr. Nujoma's plan. The influence of teachers on students in educational systems is significant. If the teachers are not qualified, the student's learning experience is going to be affected for the worse. A large number of teachers in the educational system in southern African countries do not meet the general requirements to be considered "qualified teachers" (p. 117). Allowing unqualified teachers to continue to teach students results in "the vicious circle of poor teachers producing poor students, resulting in high failure rates" (p. 118).

New and innovative teaching styles are difficult to implement in the secondary school curriculum because of the high student to teacher ratios but have proven to be a topic of interest within many Namibian schools. Learner-centered teaching methods are becoming more popular and will provide students and teachers with new methods of experiencing effective education. In a master of education thesis written by Kamwi Kenneth Kamwi (2001), two Namibian secondary schools are compared to illustrate teacher's responses to the educational reform taking place in the country. It is evident that the schools are not well organized in regards to keeping track of documents and teaching materials. Kamwi clearly describes the various teaching methods being used in the classroom, based on interviews conducted with various teachers. Even though this report is nearly eight years old and there has been some progress since, it still brings up important information regarding teaching styles. An emphasis on traditional teaching methods is quite clear, and it seems as if learner-centered teaching is not practiced often. After an interview conducted with a teacher, Kamwi sums it up

by saying "Group work is used to speed up the completion of content rather than enhancing learning" (p. 55).

Education reform has put more emphasis on making sure that secondary schools have the resources available for students to learn to their highest capability. Textbooks have been provided in classes where they were not used before and new teaching methods and syllabi have been introduced (Kamwi, 2001). In an interview conducted with one of the teachers, Kamwi was able to get a better idea of what the teacher thought about education in Namibia:

> "This [education reform] was necessary because in the past teachers used to struggle. But in this new transition learners search for information or they discuss, and then they present to you as the teacher, and at the end you make conclusions together with the learners" (p. 56).

From this information, it seems that teachers are accepting the new practices being enforced by the education reform and are willing to test them out. However, the new reform, which has tried to emphasize the importance of learner-centered teaching, has failed in regards to several aspects. Teachers do not acknowledge the importance of group work. One specific teacher who was interviewed by Kamwi (2001) practiced learned-centered teaching but in a way that displayed lack of subject knowledge. Focus was put on making sure that certain syllabi and deadlines were met instead of on meaning and discussion of issues that arose from various lessons.

Overall, teachers in Namibian schools understood the general concept of learner-centered education but did not have an overall grasp of the new teaching style that enabled them to put the method into practice (Kamwi, 2001). There seemed to be confusion about why learner-centered teaching can be more effective than the more traditional teaching methods such as teaching from a textbook and not bringing outside experiences and examples into the classroom.

2.3.4 School Demographics

Determining the demographics of each school that participates in the EduVentures program was an important factor for creating the educational game. It helped to gain a better understanding of what the environment was like in the schools that we visited and what to expect. Some of the schools that have sent students to participate in the EduVentures programs are Delta School, Jon Jonker Afrikaner Secondary School, NISE for Hearing Impaired, DHPS, St. Paul's College, Combrietum Secondary School, and Windhoek High School, (Students practice science, 2006, April 11). Delta School and Jon Jonker are both government schools with a significant difference in terms of access to resources and funding. Delta is a well-funded government school whereas Jon Jonker is an underfunded government school located in a poor section of Windhoek. NISE is an underfunded school for students with disabilities and DHPS, St. Paul's and Combrietum are all private schools. St. Paul's is one of the most prominent and well –funded schools in all of Windhoek. Another government school, Windhoek High School, was established over 90 years ago and has been rated as one of the top schools in all of Africa (Windhoek High School, 2009). Some of this school's senior secondary phase consists of

language, mathematics, biology, history, and various elective courses. More statistics on the school show that it is regarded as a very prestigious high school:

- Nine of the top 20 learners in Namibia in a country recognized exam were from WHS.
- The Ministry of Education recognizes WHS as the top mathematics school in the country.

From Figure 2, one can gain a better idea of what the classroom setting at Windhoek High School is like:

FIGURE 2. WINDHOEK HIGH SCHOOL CLASSROOM. (WINDHOEK HIGH SCHOOL, 2009)

Looking at Figure 2 we noticed that these students have various resources available to them including ample classroom space, textbooks, and school uniforms. There also seems to be some sort of learning materials posted on the back wall that helps to show that learning materials are available. The theatre type seating and uniforms shows that the school atmosphere could be very serious and structured. However, even though this figure shows that there are ample resources available to the students at Windhoek High School, many other schools in the Windhoek area do not have access to these resources. It is very difficult to find information on less developed high schools because they do not have the funding or technology to create web sites. Through visiting Jon Jonker Secondary School in Katatura and Combrietum, we determined that there is a great disparity amongst the schools. Even though Combrietum is a private school, its students do not have access to computer labs at the school. The schools we visited seemed to have ample resources to be able to effectively teach the students, however there is a great disparity amongst the quality of education students receive and the resources that they have access to.

2.3.5 Internet Availability

Increasing internet availability in Namibian schools will help to provide alternative learning experiences to Namibian secondary school students. Internet availability in Africa in

recent years has been increasing with aid from governments and the establishment of new internet service providers (Mutula, 2003). However, internet technology in Africa is still extremely limited, and the majority of African countries have little internet availability. The problem with getting internet access to schools in Africa is that the internet and communication infrastructure are poorly developed. Information technology has not been effectively integrated into the government's future plans but will have to be in order for more citizens to gain internet and computer access.

With the help of government funding, an organization called SchoolNet helps to spread internet and computer access in Namibian schools. SchoolNet has striven to give as many schools internet access as it can (Mutala, 2003). From 2000 to 2003 it was able to provide over 120 rural and developing secondary schools with computers and/or internet access. In an article written by Frauke Jensen (2001), the BBC's African Service reporter in Namibia, a SchoolNet representative quoted, "While there are no libraries, these children desperately need information resources" (p. 1). To give a better scope of technology availability in Namibia, there were 1,519 schools in 2001 and 924 (61%) of those schools did not have access to either a telephone, electricity, or a library (Jensen, 2001). The computers and internet provided by SchoolNet can sometimes be unreliable but they provide schools with resources that they would not have access to otherwise. SchoolNet provided NISE with its current computer lab, which consists of two computers in a very small room.

If people in Namibia want to be connected to the internet they will need computers, and computers need operating systems to run. This poses a problem because operating systems such as Microsoft Windows are not inexpensive. Groups such as SchoolNet Namibia help to provide less developed countries with gaining access to open-source software such as Linux (Weiss, 2005). Figure 3 shows some of the places in Africa where open source software is used most. One of the founding directors of SchoolNet believes, "If we [SchoolNet] can get the price of hardware down to what we pay for mobile phones today, we'd be in business, we would be well on our way to bringing the spread of technology across the African continent" (Weiss, 2005, p. 38).
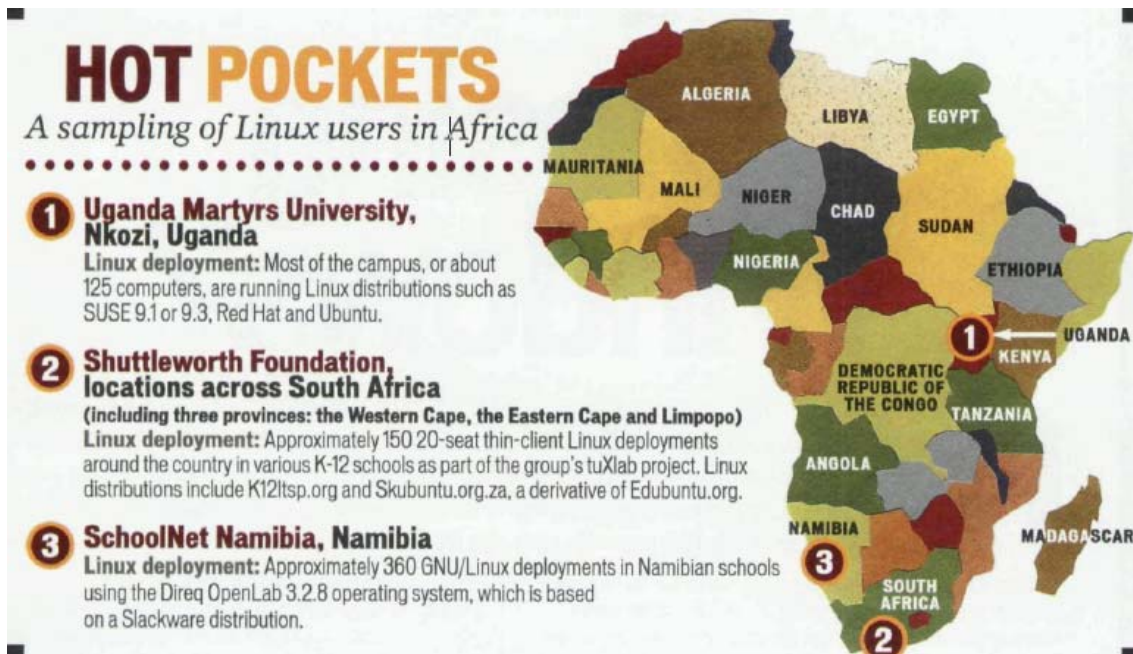
FIGURE 3. OPERATING SYSTEM AVAILABILITY IN AFRICAN COUNTRIES. (SOURCE: WEISS, 2005).

2.4 EDUCATIONAL COMPUTER GAMES AND OUR TARGET AUDIENCE

The target audience for EduVentures has mainly been 14-17 year old secondary school students in Namibia (Mapfumo & Vollbrecht, 2008). Establishing a target audience has helped us to determine how to develop the material displayed on an educational game, how the majority of viewers are going to react to the material being taught, and how to market the game to ensure that it will be used to increase students' knowledge about the subject. Without the establishment of a target audience, it would have been very difficult to decide what type of content to add to *WebExpedition*. Namibian students limited access to educational games and computers is going to be an issue when trying to market *WebExpedition* to the students and teachers.

Computer and internet access in Namibia are still in the developing stage. They are not available to all Namibian people and are certainly not available in all schools. However, with technological changes in Namibia and the government's emphasis on introducing computer technology to the country, more opportunities are becoming available for students to learn various subjects through computer-based educational games. The problem is that the main learning environment for students is the classroom, and the classroom is headed by a teacher who has a particular curriculum and structure that he or she feels comfortable with. If alternative learning tools are being brought into the current school curriculum, the teachers may not be as effective in their teaching styles because they are not famililar with these new

methods. Teachers need to actively participate in training programs that are available to them to help them better adapt to the new technology in teaching methods (Chapman & Mahlck, 2004).

Teachers' lack of technology use in developing countries is due partly to the fact that integrating the material into the current curriculum can prove to be a difficult task, and one that is very time consuming. Even if the efforts are extremely time consuming, the end result will be well worth it. Initiatives in research linking education with technology have proven that students can learn faster and more efficiently through the use of technological learning tools. Bellman (2001) helps put the problem of implementing technology in classroom settings into much better context:

> …We have seen the development of some stunning beginnings in educational technology, but it's not yet the right stuff. Education technology needs to support different teaching and learning styles, gracefully specialize into individual differences, handle diverse theories of pedagogy and learning, evaluate performance within a variety of media, support group as well as individual learning, and incorporate deep and rich content resource (p. 379).

In Namibia, the use of technology in a classroom setting has yet to be established in an easy, affordable, and efficient manner. The goals of *equity, access, quality,* and *democracy* have become the backbone for educational change in Namibia (Chapman & Mahlck, 2004). As expressed in the International Institute for Educational Planning's report, a movement established by the Computer –Assisted Teacher Training [CATT] program in Namibia in 1999 stated that it would strive to reach several objectives (Chapman & Mahlck):

1. Establish an information and communication network for education professionals;
2. Develop the capacity at the National Institute for Educational Development to develop multimedia teacher training materials;
3. Develop model teacher training materials for online and CD ROM delivery;
4. Develop a cadre of technology champions;
5. Provide IT policy support to Namibia's Ministry of Basic Education, Sport, and Culture (p. 193).

The problem with these objectives was that Namibian teachers had never been introduced to technology in an educational setting before. The teachers all had their own teaching syles which they were accustomed to and were not ready for a major restructuring of their educational system. An analogy presented by Chapman & Mahlck (2004) helps explain the problem within the Namibian education system:

It has been somewhat akin to approaching a cook that, for years, has been asked to make one dish following a very precise recipe, and telling her that it is much better if she allows the food to tell her what it wants to become. Then, when she asks how to do this, continue to provide her with ever more in-depth explanations and books on why this approach is important, but never once provide her with a demonstration or hands-on experience with the process (p. 194).

Even though these new objectives in the Namibian educational system have proven to be difficult for teachers to adjust to, it has been recognized that new technology can greatly enhance the effectiveness of teaching. Some of the various ways that technology and online resources can be used within education systems are listed below (Chapman & Mahlck):

1. *Direct instruction.* This is the most popular among the teaching methods and is most effective for developing countries in which the teachers are under qualified for the specific grade that they are teaching. It allows easy access to one centralized teaching location either through the radio, television, or through the computer.

2. *Find and access resource materials.* These materials are used to implement the teacher's specific teaching style and lesson plans.

3. *Access curriculum and instructional guides.* Teachers can find materials on the web to assist them with running a lab activity or other instructions to an activity.

4. *Find and retrieve information.* Used for students in school systems with access to technology that allows for independent study. Not an adequate approach for teaching in underdeveloped countries.

5. *Connect two or more classrooms.* Two classrooms from different parts of the world are connected and are able to communicate with each other to allow everyone to engage in a learning environment.

6. *Lessons broadcast to multiple classrooms.* A positive aspect is that it allows students in remote areas to maintain contact with teachers in a central location.

7. *In-service teacher education.* Allows a teacher to more easily participate in professional development activities (p. 23).

These approaches can be difficult to include in a classroom for several reasons. One reason is that the school system may not even have the technology available to allow for these types of learning. The second reason is that the teacher has to adapt to this new technological approach into their current teaching style and curriculum. Breaking it down even further, Chapman & Mahlck (2004) explain the four main problems for developing countries to access

newer technologies as: (1) access is expensive, (2) ensuring equity of access is difficult, (3) retraining teachers to use the new technology is complicated and costly, and (4) inappropriate content poses a problem. These four problems have to be taken into consideration when trying to market *WebExpedition* to secondary school students.

2.4.1 Marketing Strategy and Target Audience

One of the first steps in marketing a game is determining an actual market and a marketing strategy (Armstrong & Kotler, 2006). The marketing strategy helps determine the target audience and how the organization doing the marketing will create value for the audience.

An important aspect to the marketing strategy is to identify competitors and other organizations that could help with the marketing of the game. A large part of this is to identify a value proposition, or how this specific product is going to stand out from its competition (Carlson & Wilmot, 2006). It was very important for our project team and mainly EduVentures to understand our target audience and create value within the educational game. In his book on innovation, Curtis Carlsen (2006) explains, "They [products] fail not because of technology, resources, or a dozen other reasons. They fail primarily because customers did not want them: the enterprise did not understand its customers' needs" (p. 5). Fully understanding the Namibian students and teachers who are going to be using the *WebExpedition* and any outside organizations that could help with the marketing of the educational game proved to be an essential step in the design stage of this project.

2.4.2 Use in the Classroom

Ensuring that the EduVentures *WebExpedition* could be successfully used in a classroom setting was essential for marketing the game to potential teachers and schools. In biology classrooms, teachers have used web-based games to better illustrate laboratory experiments that could not have been conducted in the normal sense because of limited resources and equipment (Bodzin, Waller, Santoro, & Kale, 2007). Since lab equipment in Namibian secondary schools is limited, educational games can give students another means for gaining knowledge about laboratories in a science setting. Another advantage to using educational games is that the user can control how fast he or she goes through the educational game; the game can be tailored to the student's learning style. Certain limitations to computer-based educational games have been discovered including the student's attention span and ability to stay focused. After researchers compared and contrasted the method of students working on an individual computer versus working on a large projected screen, they noted an increase in productivity from 42% to 88%. When students were focusing on the large projected screen, they were more

productive because the teacher could better monitor what the students were doing. Individual computers are more difficult to monitor because the teacher would have to be looking at each student's computer screen.

2.5 SUMMARY

Continuing to teach secondary students about science and environmental education has proven to be an important investment for scientific research and educational systems. Without knowledge about the environment, we would not be able to understand large issues that are shaping the world's ecosystems. There have been specific pedagogical techniques for communicating this information to students, but one of the main issues in trying to do this is making sure that the specific technique can be effectively included in current educational systems. From the teacher's perspective, there are certain ways for teaching students about biology and science, and if those methods are disrupted, they could also disrupt the information that the students learn. The individual teaching styles of teachers need to be identified in order to determine how educational games can be incorporated into current curricula. Education systems have many limitations that prevent educational games from being included in curricula. Limited technology and internet availability make it difficult to teach students about science through computers. The next chapter will explain how we have determined how an educational game aimed at teaching secondary school students about environmental issues and biodiversity can best be included in an education system. We explain how we decided on the best way to create the game and what specific content best interested the targeted students.

3 METHODOLOGY

The goal of this project was to create and deploy an interactive, computer-based educational game that provides secondary school students with a fun and effective way to learn about biodiversity and environmental issues. In order to achieve this goal, we assessed the needs of the target audience and determined the content of the game. To do this, we conducted surveys, interviews, and focus groups with EduVentures staff, Namibian teachers, and secondary school students. Obtaining information using focus groups and questionnaires helped us understand what content to include in the educational game. To facilitate *WebExpedition*'s support of the current curriculum of secondary schools in Namibia we developed suggestions for how the game can fit into the classroom. We used the ideas and information from all of these resources to design and implement an interactive game using Adobe Flash software. We created stand-alone and web versions of the game. We showed that the game was functional and made improvements via beta testing. We then determined how effective the game was by allowing Namibian students to test it.

3.1 DETERMINE PREFERRED CONTENT FROM EDUVENTURES STAFF

Since EduVentures was the sponsoring organization for this project, it was extremely important to know their specific needs, goals, and objectives. To accomplish this, we held a focus group with the staff. The group we interviewed also included a few people who were not officially staff members, but work closely with EduVentures. In order to understand what EduVentures wanted from *WebExpedition*, the focus group allowed the employees to share ideas amongst themselves. Through it, we gained a better understanding of what they wanted this educational game to accomplish.

We drafted a set of questions that helped to guide the focus group. Using open-ended questions and conducting the focus group in a setting where the employees felt comfortable were both extremely important. We started by presenting our vision for the project. Then we asked for their ideas about what should be included in the game, and what their priorities were for *WebExpedition*. The protocol was written to maximize the information obtained about EduVentures as an organization, potential schools to collaborate with, and secondary school teachers who were to be interviewed. Please refer to Appendix F for the protocol that was used.

The questions from the protocol were also sent to the EduVentures members who were not able to attend the focus group. This was important because it allowed us to get ideas from all of the employees.

3.2 ENSURING THAT SECONDARY SCHOOL TEACHERS UNDERSTAND THE EDUVENTURES *WEBEXPEDITION* PROJECT

Before we conducted interviews with secondary school teachers and students, it was imperative for the teachers to understand what the EduVentures *WebExpedition*'s mission, goals, and objectives were. To accomplish this we first contacted EduVentures to find out which teachers from the 15 partner schools should be contacted. EduVentures was able to give us a list of 10 schoolteachers who would be good to contact, and their schools are listed in Table 2. we invited these teachers to the National Museum of Namibia and gave a presentation on the *WebExpedition* to inform the teachers about the purpose and goals of the project. This initial list of teachers contained the teachers with whom we continued to conduct one-on-one interviews.

Included in this list of schools is NISE (Namibian Institute for Special Education). Since EduVentures has taken hearing-impaired and deaf students from this school on expeditions in the past, it was important to ensure that hearing-impaired students could also benefit from the game. This meant that working with the teachers from NISE was extremely important.

TABLE 2. LIST OF SECONDARY SCHOOLS CONTACTED

School Name	Private/Gov.
NISE	Gov.
Shipena	Gov.
Khomas HS	Gov.
Combrietum	Priv.
Delta	Gov.
St. Pauls	Priv.
DHPS	Priv.
Jon Jonker	Gov.

3.3 DETERMINING HOW HEARING IMPAIRED STUDENTS CAN BENEFIT FROM THE GAME

In order to determine how hearing impaired students can effectively learn from the educational game while having fun, we interviewed Jonas Kazondunge from NISE and Heide Beinhauer from CLaSH (the association for Children with Language Speech and Hearing impairments of Namibia). The interview with Ms. Beinhauer allowed us to be able to communicate better with the students who are enrolled with NISE. The interview protocol can be found in Appendix N. This better informed us on methods to make the game useful for deaf and hearing-impaired students.

3.4 DEFINE FACTORS THAT FACILITATE USE IN CLASSROOM

Namibian secondary school teachers have a strong influence on what teaching approaches are used to help the students with learning the material. However, these teachers also have to cover the standard curriculum that is required by the Ministry of Education. These teachers have their own teaching styles and opinions on what methods work and what methods do not work. The teachers that we worked with were from schools that were currently sending students to participate in the EduVentures expeditions. These teachers were contacted and asked if they would be willing to be interviewed. These interviews helped the project's direction by finding out the willingness of teachers to implement *WebExpedition* in the current curriculum of their particular school. The specific questions for the teachers were based in part on trying to determine how the teachers thought an interactive or computer-based educational game would best fit into the curriculum. They were also based on determining the content that the teachers wanted to see placed in the game. A focus group and individual interviews were both conducted to determine the teacher's opinions of interactive educational games. For the interview protocol used with secondary school teachers, please see Appendix G.

In addition to working with teachers, we also interacted with students as part of the research for the development of *WebExpedition*. One of the main goals for creating an interactive game on the EduVentures website was to help increase Namibian secondary school students' awareness about local biodiversity and environmental issues. This game was successfully created partly because we were able to find information about secondary school students' attitudes toward the environment and local biodiversity. If the learning game is not appealing or interesting to the students, the goal of our project would not have been fully achieved. It was essential to understand what content would best fit with students' interests and to identify the best methods for motivating them.

We conducted focus groups with students at different schools as well as several individual interviews with students who had participated in the EduVentures program. The protocols for interviews with EduVentures participants can be found in Appendix R. The focus groups were comprised of groups of students from Delta School and NISE, and were held at the schools to ensure that the students could attend the focus group. The focus group held at Delta School was comprised of three grade eleven students, and the one at NISE was with seven grade ten students. The questions asked in the focus group with Delta students can be seen in Appendix H. The questions asked in the focus group with NISE can be found in 0.

We contacted students by asking the teachers to find students whom they thought would be interested in our project. We also determined which students would partake in the

focus group by creating a flyer to post in the secondary schools, which asked the students to contact us if they were interested in participating. Focus groups conducted with the students allowed for ideas to be generated and helped to decrease any anxiety that the students may have had when they were being interviewed.

3.5 REINFORCING USABILITY IN CLASSROOMS

In order to determine how *WebExpedition* could be used in the classroom, it was imperative to observe teachers in action at local Namibian secondary schools. According to George (2000), observation allows the researcher to collect information first-hand rather than relying on what other people have researched and found through their own methods. This method mainly served as a means for determining how the secondary school teachers teach and material they were teaching so that we could design usage recommendations accordingly and determine how well our educational game fit with their teaching styles. We created a list of recommendations for the use of *WebExpedition* in the classroom which can be viewed in Appendix U.

The schools and teachers that were observed were selected from among the schools that have already participated in the EduVentures programs. We observed two teachers from different schools. One was from Combrietum School and the other teacher was from the Namibian Institute for Special Education. During the observations of the classes, we strictly acted as observers and did not interact in any way. Through observing the classes, we looked for the following:

- Structure of the lesson
- Interactive aspect and student involvement in the classroom;
- Whether *WebExpedition* would fit into the current lesson being taught.

These criteria were looked for and analyzed as we were observing the teachers teaching. The structure of the lessons helped us to create suggestions for teachers to use to help link *WebExpedition* with the biology curriculum. The suggestions list various ideas that teachers can use to help introduce *WebExpedition* to students. We want teachers and students to know that the objective of the game is for students to learn more about Namibia's environment and biodiversity.

3.6 DETERMINING SPECIFIC CONTENT

We determined the specific content for *WebExpedition* by speaking to experts with knowledge of Namibian animals and plants. Our goal was to include some species that students

will already be able to identify with, and some more unusual ones that will intrigue and excite learners. In order to gain information on animal and plant species that were included in the game, we interviewed several experts. Patrick Rickert is a professor of Nature Conservation at the Polytechnic of Namibia, and Tharina Bird is an arachnologist at the National Museum of Namibia. Both Patrick Rickert and Tharina Bird worked with us in developing a list of quality organisms to include in the game. We also interviewed Silke Rügheimer of the National Botanical Research Institute (NBRI) of Namibia, asking about the most fitting plant species to include in the game. Through this, we sought to gain a good representation of species around Namibia.

3.7 CREATING THE GAME

In order to achieve our goal of teaching and inspiring students about Namibian biodiversity and environmental issues, we created an interactive computer game. We previously discussed how we collected information about the wants and needs of students and teachers, as well as additional information about what EduVentures staff wanted to incorporate in the game. This information was synthesized with our background research on effective methods for designing educational computer games. As we created the game, we wrote documentation for EduVentures that will allow others to make changes in the future.

3.7.1 DESIGN STRUCTURE

We used Adobe Flash software as the development instrument for our game. It offers ample versatility in the creation of an educational computer game. Flash facilitates the creation of graphics and animations that can be seamlessly integrated into an interactive environment. Graphics and animations created in Flash are small and can be encapsulated for simple insertion into a website. ActionScript, Flash's embedded programming language, is relatively easy to learn and work with, especially for those new to programming. In addition to these factors, ActionScript and Flash have the following important features:

- Easily updated to include new content
- Easily added as part of a set of modular activities
- Portable
- Small file size
- Easily embedded into a web page
- Functional across all operating systems

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When constructing the game and web page, we realized that it would be relatively simple to distribute *WebExpedition* as a stand-alone package. This page can be downloaded easily online, and can be distributed with flash player on CDs.

The interface of the game deals with aspects like controls and instruction methods. *WebExpedition*'s interface is a basic point and click system where the user navigates through the environment by clicking on menus and buttons. The way in which we designed the interface of our learning game depended partially on the target audience's experience using computers. In order to design a game that students can interact with well, we needed to understand where students use computers, how they use them, and how much experience they have using computers. To accomplish this, we distributed questionnaires in the schools we visited that ask questions about students' computer experience. We asked the teachers we made contact with to pass them out to their students in class. The questionnaire that we used can be viewed in Appendix I.

Although the sample of students that this questionnaire reached was not representative of all students in Namibia, it informed us about the computer experience of the students in the schools that are in our immediate target audience. The game's interface was refined as we gained more information about how Namibian students interact with computers.

3.8 ENSURING CONTENT ACCURACY AND GAME FUNCTIONALITY

Before an educational game is launched, it should be tested with students to ensure that it is functional, clear, and correct (Gagné, 1992). We therefore conducted a beta test with 24 grade nine students from Delta School. A beta test is the test of a piece of computer software on a small community before being released to its entire audience. The students played the game in groups of roughly eight students, one student controlling the computer and the rest observing. In the beta test, we introduced the students to the game, and then let them play for 15 minutes. As they played we observed, and aided the students who had difficulties or questions. Following the beta tests, we conducted a focus group with these students to receive feedback about successful aspects and areas for improvement in the game. The questions for this focus group can be seen in Appendix K.

The ability to evaluate an e-learning game is essential in order to help convince educators that it is a worthwhile game and to see the effective qualities of the game (Fu, 2009). In any lesson plan, it is necessary to evaluate whether or not the lesson is achieving its objectives (Gagné, 1992).

Following modifications based on beta tests, we tested the game with a group of eight first-year students from the Polytechnic of Namibia. The further testing of the game provided an opportunity to gain much information about it. In order to see if learning objectives have been achieved, teachers typically monitor the changes in the numbers of "positive" and "negative" responses in the class over long periods of time (Gagné, 1992). Although we could not measure their responses over long periods in the context of these games, each player made choices at different stages of the game. These choices are called "nodes" (Gibson, 2007). Using a technique called "avatar recording," we can collect passively and anonymously a variety of data at these nodes. At nodes, we had the game monitor whether choices were positive, negative, or neutral. We measured the changes in these responses through the course of the game. Avatar recording can also record other statistics that provide information on the clarity of the game's objectives, difficulty of the challenges, and user enjoyment. To do this, we measured and recorded the length of different intervals. In addition to these passive, indirect measurements of enjoyment and learning, it was essential to get a sense of how much the game was enjoyed directly. For this purpose, we used a modification of the EGameFlow scale developed by Fu et al. (2009). This scale was chosen because of its specificity to e-learning games and Fu et al.'s large number of field tests that show validity. The questions asked are shown in Appendix L.

3.9 SUMMARY OF METHODS

In order to expand EduVentures' ability to increase Namibian students' awareness of the biodiversity and environment of their country, we constructed an interactive computer game called *WebExpedition*. The design of *WebExpedition* took into account information we gathered from EduVentures staff, as well as Namibian secondary school teachers and students. In addition, *WebExpedition* incorporated basic educational concepts and pedagogical elements important to educational games. We tested this game in a small beta testing scenario that allowed us to find flaws in our construction as well as get input on how to improve the game. Once we made changes based on these beta tests, we conducted a field test of the game. This field test demonstrated the game's ability to reach learning objectives by allowing us to gather information monitored from within the game. In addition, we rated the game using the EGameFlow scale.

4 RESULTS AND ANALYSIS

Our game, EduVentures *WebExpedition*, has proven to be a very interesting game to the students and teachers whom we worked with. Namibian students can use *WebExpedition* as an alternative method to learn more about Namibia's biodiversity and environment. Environmental education and biodiversity are extremely valuable subjects to Namibian schoolteachers and students. In order for the students to learn about these subjects in the game, the right material had to be included. We were able to get many recommendations and feedback regarding content from professors at the Polytechnic of Namibia and from researchers at the National Botanical Research Institute. By getting input from these experts, the content included in the game was a good of a representation of the biodiversity in Namibia. After determining the content that would be included in the game, we developed the game. Once the game was playable, we evaluated it by testing it on students. Implementation of *WebExpedition* into the classroom and getting students to enjoy the game were aspects that were extremely important for the success of the game.

4.1 DETERMINE THE STATUS OF ENVIRONMENTAL EDUCATION IN NAMIBIA

We have determined that environmental education is a valuable part of Namibian students' education, and could benefit from more reinforcement. According to teachers in the Windhoek area, students who live and go to school in the city have very little exposure to the biodiversity of their country. As a result, students have a limited understanding of the value and state of the biodiversity of their country. They are not aware of common species such as spiders, and often fear them for incorrect reasons. In addition, the context of peoples' effect on the environment is not well understood by the students.

We observed a difference in attitudes among students who had experienced an EduVentures expedition and those who had not. The students from the focus group at Delta school displayed a basic understanding of biodiversity, but they admitted that they were isolated from their natural environment. One student stated that the species who are not fit enough to survive should become extinct because there are new species being created all the time as old ones die out. He stated that much of the extinctions are the fault of humans, but did not express a concern about the permanent loss of species. An EduVentures participant said that she felt as though they were part of nature when on the expedition. Another participant learned that animals such as spiders can be harmed if not handled in the correct way. There was a contrast in appreciation and respect for the natural environment between EduVentures

participants and non-participants. Although this is comparison of just a few students' attitudes, it still shows the value of an experience like going on an expedition in creating environmental awareness and appreciation.

The primary place where students are exposed to information about biodiversity is in schools, and teachers are constantly looking for tools to get students excited about the environment. Several environmental topics are taught in grades eight through twelve. For example, characteristics, classification, and diversity of organisms appear on the grade eleven and twelve biology syllabus, which can be seen in Appendix D. Teachers are still looking for more visual and hands-on ways for students to learn about the environment. In the focus group we held with teachers, they explained some methods that they already use to get students interested in the environment. An example was bringing seaweed samples back from Swakopmund to let students hold it and see it. They said that hands-on, interactivities are great at getting students interested. This leaves an excellent opportunity for *WebExpedition* to make an appearance in the classroom.

4.2 DETERMINE CONTENT

In order to effectively design content that would educate students about the environment, we conducted a focus group with EduVentures staff to determine the learning objectives and game play ideas that they wanted to be included in *WebExpedition*. Meeting with EduVentures helped confirm that our original ideas for *WebExpedition* were consistent with the ideas that EduVentures had in mind. We also interviewed other experts on the biodiversity of Namibia to identify specific content ideas for the game.

4.2.1 Determine Preferred Content

We found that the EduVentures staff had the following learning objectives in mind when they established the idea of *WebExpedition*. These are listed in descending order of importance.

1. The students have a general sense of the biodiversity of Namibia.
2. The students are generally aware of the research going on at the National Museum.
3. The students are aware of the EduVentures program, even if they are not able to participate.
4. The students are aware of environmental conservation topics.

Due to our limited development time, we decided to focus primarily on the first three objectives by allowing the students to participate in a "Virtual Expedition." On these expeditions, the students would be allowed to go to the four major biomes of Namibia, and

depending on where they clicked on the map; they would see a different variety of organisms. For more information on the biomes of Namibia, refer to Appendix C. Organisms were chosen because they were either very common or likely to be seen by the students, or because they are rare and interesting. In order to fit the game more easily into the school curriculum, students would practice giving taxonomic names of the organisms in order to gain points. The idea of taxonomic classification of animals in the game is supported by the grade twelve biology syllabus shown in Appendix D. Section I of the syllabus or "Characteristics And Classification of Living Organisms," states that students must "know & use a classificatory system." *WebExpedition* will be a tool that will help students with the learning objective of knowing and using a classificatory system.

4.2.2 Determine Specific Content

Through collaboration with several experts on Namibia's environment and biodiversity, we were able to get a much better understanding of what content and information should be included in the game. It was extremely important for us to keep track of which ideas were necessary for the success of the game and which ideas were less important.

Collecting ideas about plants and animals in Namibia's biomes from Professor Patrick Rickert, a professor of Nature Conservation at the Polytechnic of Namibia, helped us understand why certain species were important to Namibia's environment. Professor Rickert has been working with EduVentures for several years and has collected many photographs of the animals and plants in Namibia's environment. Figure 4 and Figure 5 show some of the photographs that were taken on EduVentures' expeditions and were used in creating *WebExpedition*. Professor Rickert helped in giving us feedback on which plants and animals to include in the game. He thought it would be a good idea to include species that were going to be interesting to the students and that play important roles in the biomes in which they are found. For example, he explained the important role that lichen fields play in protecting Namibia's soil.

FIGURE 4. *OPISTOTHALMUS HARPEI* (EDUVENTURES)

FIGURE 5. GLADIATOR (EDUVENTURES)

Silke Rügheimer of the National Botanical Research Institute (NBRI) of Namibia provided us with more information regarding our selections of plants in the various biomes. We came up with a list of plants that we thought would be a good representation of the plant diversity in Namibia and provided it to her to analyze. She suggested that we do not include certain plants and to add certain plants where necessary. For example, Silke recommended that we include the bushman's candle (*Sarcocaulon patersonii*) in the desert biome and the halfmens (*Pachypodium namaquanum*) in the Succulent Karoo biome because these plants are interesting and would give the students a better understanding of the diversity of botanical species in Namibia. These recommendations were extremely helpful because they allowed us to decide which plants we should include in the game

Through collaboration with Silke Rügheimer from the NBRI, we found a biodiversity card game called the *Namib Quartet* that the Desert Research Foundation of Namibia (DRFN) sells to help people learn more about the plants and animals in Namibia. These cards have pictures of some of the species of plants and animals that are found in the Namib desert and include information such as distribution maps, size of the species, along with some scientific taxonomy. The cards were used as a guide for some of the species we selected and helped to spark additional thoughts. Figure 6 is an example of one of the cards from the DRFN game.

FIGURE 6. DESERT RESEARCH FOUNDATION OF NAMIBIA OSTRICH CARD (VON OERTZEN, N.D.)

TABLE 3. PLANT AND ANIMAL SPECIES TO INCLUDE IN GAME

	Desert	Savannah	Succulent Karoo	Nama Karoo
Animals	Dancing white lady spider	Black mamba	Barking gecko	Large huntsman spider
	Dune lark	Pangolin	Opistothalmus harpei	Monkey beetle
	Horned adder	Gladiator	Cheetah	Namaqua chameleon
	Solifuge	Ostrich	Springbok	Parabuthus schlechteri
	Opistophthalmus flavescens	Termite's	Large huntsman spider	Padloper tortoise
Plants	Milk weed	Bushman poison	Namib lily	Quiver tree
	Tall bushman grass	Tamboti tree	Pig's ear	Halfmens
	Welwitschia	Vermeerbos	Quiver tree	Mesembryanthemacae
	Wild everlasting	Silky bushman grass	Halfmens	Bushman's candle
	Wild green hair tree	Camelthorn	M. hypertrophicum	Lithops karasmontana

In order to teach the students effectively about the various plants and animals listed in

Table 3, we determined that the material had to be presented in an interactive manner. An interactive aspect of the game will keep the students interested in the game and will help them learn. We had the initial idea of having the students classify the species according to their scientific taxonomy because this coincided with what EduVentures had in mind. If students understand the environmental issues affecting their country, then they have some initial knowledge to help to solve the issues. For example, if students know that the cheetah is a protected species and know that it brings in money each year through tourism, they may want to help in coming up with an innovative solution towards conserving cheetahs. We also decided to include a distribution map of where specific plants and animals are located (See Figure 7). Knowing exactly where black mambas and specific scorpions are found in Namibia can help students be more prepared when walking in an environment with poisonous animals.
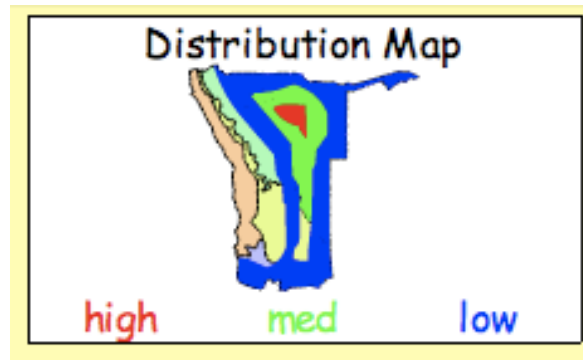
FIGURE 7. SCREEN SHOT OF DISTRIBUTION MAP OF BLACK MAMBA

4.3 DEVELOPMENT

Development of *WebExpedition* was one of the most crucial steps for the success of our project. If we did not meticulously portray the content ideas that were compiled by EduVentures in the game, then the users of the game would not be learning the material. We wanted to make sure that students would enjoy learning about biodiversity in Namibia. Assembling a design document and developing an initial list of ideas for *WebExpedition* allowed us to keep our options open and to choose the ideas that would best fit into our learning objectives. In order to make the game more usable and expandable, we created a simple yet easily expandable system to input data. We decided which documentation to include, and then created version 0.1 of *WebExpedition* to test on secondary school students. Beta testing the game on students was extremely valuable because it allowed us to get feedback on the game and to ensure that the game functioned as intended.

4.3.1 Accompanying Documentation

Due to the lack of technical resources at EduVentures, we designed *WebExpedition* to be easily expandable in the future without the need for knowledge of programming. In order to do this, we created a sister program called the SpeciesEnterer that manages all the information about species, a screenshot of which can be seen in Figure 8. We created a Users' Manual for the game to show how to enter the graphic information using Adobe Flash. This allows the EduVentures' staff to enter new organisms without having any computer science background. The Owners' Manual can be found in Appendix T.
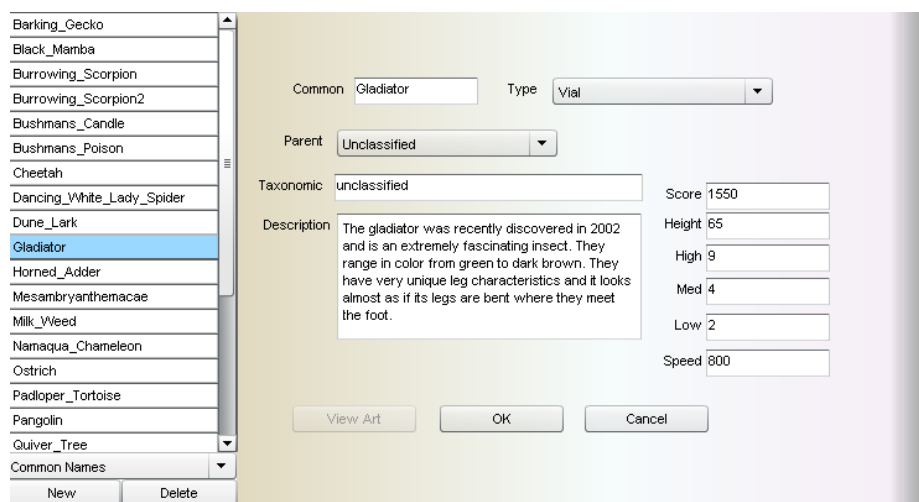
FIGURE 8. SPECIESENTERER

In order to facilitate more complex development and to organize our design process, we created a design document for *WebExpedition*. This document includes an organization chart of the code, and UML (Unified Modeling Language) class structure of the code. The design document can be found in Appendix J.

4.3.2 Design of *WebExpedition* V 0.1

For the development of *WebExpedition*, we created a list of its possible features as part of our design document. We divided these features into optional and required features, and organized them in an order of importance. These were:

- Required Features
    - Save game
    - Point system
    - Classification game
    - Environments with features
    - Training course

- o Biome areas: desert, Nama Karoo, Succulent Karoo, savanna, Etosha
- o Collection
- o Further classification
- o Interface
- o Ability to turn
- o Ability to act on objects
- o Ability to catch samples
- o Organisms
- o Animal distribution map
- o Still icon when caught with information
- o Classification
- o Game elements
- o Hint system
- Optional Features
  - o Animated organisms in expedition sites
  - o Purchasable items
  - o Vehicle selection
  - o Shop
  - o Benson, EduVentures employee and researcher
  - o Encounters with environmental issues at sites
  - o Email/SMS from scientists
  - o Other museum activities

WE NEEDED TO KEEP THE FILE SIZE OF *WEBEXPEDITION* AS SMALL AS POSSIBLE SO THAT IT WOULD BE ACCESSIBLE EVEN WITH SLOW INTERNET ACCESS.TO DO THIS WE AVOIDED USING PHOTOGRAPHIC IMAGES IN THE GAME. INSTEAD, WE CONVERTED IMAGES OF THE ORGANISMS INTO CARTOON ART AS SEEN BELOW IN FIGURE 9 AND

Figure 10.

FIGURE 9. NAMIBIAN BARKING GECKO (EDUVENTURES)
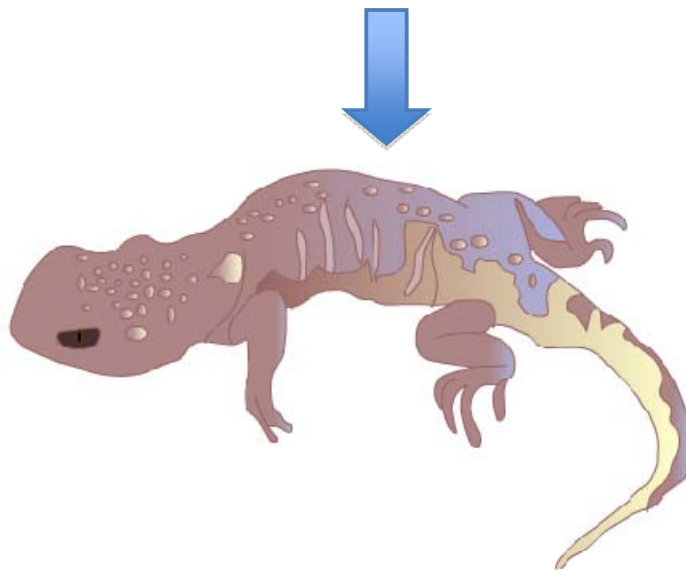
FIGURE 10. CONVERSION OF A DIGITAL PHOTO TO AN ADOBE FLASH COMPUTER IMAGE

We felt that it was essential for users to be able to save their progress in the game. Users would most likely have limited access to computers or the internet and therefore would be able to play *WebExpedition* for only very limited amounts of time. Being able to return to their game in progress was an essential part of *WebExpedition*. In addition, we wanted the users to be able to see their progress. In order to do so, we implemented a point system for the users, as well as a collection system for viewing of all the organisms they had classified correctly.

Training was an essential part of the *WebExpedition*. Most of the users of *WebExpedition* will not be highly experienced computer users and thus, explicit instructions were necessary. We started the user at the front of the National Museum, where a student, Tauno, introduces

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EduVentures and the *WebExpedition*. Tauno is a pedagogical agent to which the students can connect. The user then goes to the lab, where Tauno explains the collection on the workbench.

FIGURE 11. SCREEN SHOT OF TAUNO INTRODUCING *WEBEXPEDITION*

We chose to use Tauno for the tutorials because he is a character who has already been used by EduVentures. We started outside of the museum so the students could be introduced to the game and that EduVentures is affiliated with the National Museum of Namibia.

Once the user has entered the museum, Tauno leads the user to the map. Here, he tells them about how they can find different animals in the various biomes.
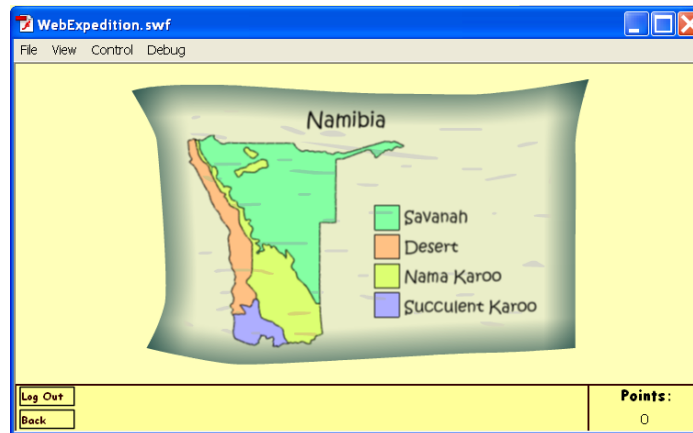
FIGURE 12. THE WEBEXPEDITION MAP

From here, the user can click on the map and go into *WebExpedition*. Because we want this game to be usable by users without much computer experience, Tauno then outlines with graphics how the user can look around the expedition site environment. We chose the map because it is an easy, visual way for the users to learn about the biomes of Namibia. When the user clicks on the map, he or she is taken to an environment reflective of the biome, and animals appear in the world based on real distribution maps. Because students can see where they click on the map, they can learn where organisms can be found once they find organisms.

FIGURE 13. THE EXPEDITION SITE TUTORIAL

When the users click on the map, they are taken to the biome they clicked on. Because we wanted *WebExpedition* to be usable by users with minimal computer experience, we have Tauno explicitly show how the users can move using the arrow keys and how they can click on plants and animals.
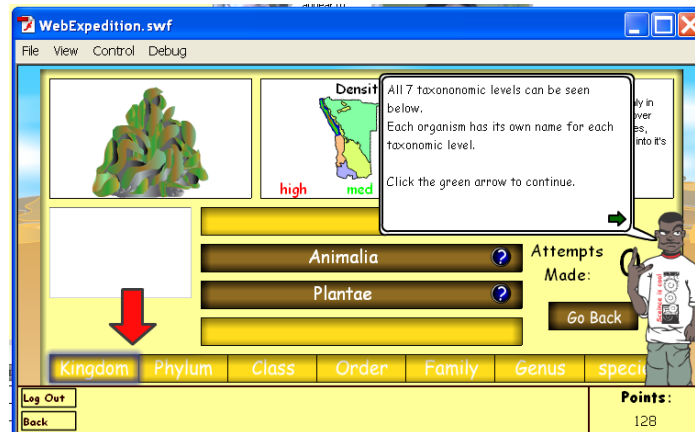
FIGURE 14. NAMING GAME TUTORIAL

Tauno also explains the naming game. Here the user is challenged to classify an animal or plant based on the taxonomic naming structure. Tauno explains the taxonomic levels, and arrows are used as visual cues. Once the users complete the tutorial, they can make selections for each taxonomic name of the selected organism. The blue hint buttons next to the name of the taxon allow students to learn about what each taxon is. In order to make the game more difficult, the choices for the taxonomic levels are taken from the closest relatives of the correct taxon. When game development was complete, we had a game that would teach students about the biodiversity of Namibia in a fun and interactive way.

4.4 USING *WEBEXPEDITION* IN THE CLASSROOM

WebExpedition is a valuable educational tool that can be used to teach secondary school students in Namibia about their country's biodiversity and environment. Using it as a part of classroom activities or as a supplement to related materials in the classroom will help to reinforce topics such as biodiversity and scientific classification. We aimed to determine the best ways for *WebExpedition* to be used in schools as an educational tool. Teachers in secondary schools were very excited at the initial idea of *WebExpedition* and were even more excited when WebExpediton was fully developed. Our objective of making sure that *WebExpedition* is usable in classrooms was reached after we tested the game on secondary school students and showed the game to teachers. The students had fun while learning from the game and the teachers thought it would be a great tool to help reinforce scientific classification and biodiversity studies.

4.4.1 Determining Students Motivational Factors for Learning

The computer usage survey completed by secondary school students helped us determine that the students believe educational games help them learn. Refer to Appendix I to view the survey.This survey collected information from over 240 students from five different secondary schools in Windhoek. From the computer usage survey results, we discovered that 68% of the students who have never had access to educational gameswould like access to educational games. Fifty-eight percent of students who have access to educational games already believe that the games help them learn. Based on individual interviews with students, we found that students showed interest in playing a game like *WebExpedition*, and indicated that other students would also like to play a computer game about biodiversity. These results suggest that *WebExpedition* is likely to be used by students if it is made available to them.

The majority of students that we encountered had an interest in science and showed an eagerness for learning in general. During a visit to the NISE, six out of seven students expressed an interest in a specific scientific topic. In the focus group with grade eleven students from Delta School, three of them talked about lab experiments that interested them. Their favorite learning activities in science were all hands on activities such as lab experiments and projects. These findings with students matched up with the feelings of teachers regarding the teacher's attitudes toward learning. In the focus group with teachers, the consensus was that students are very excited to learn, especially in new ways. The main challenge with students is insufficient knowledge, not insufficient motivation to learn.

4.4.2 Facilitate Use in Classroom

Educational computer tools for secondary school students would not be useful if students did not have access to computers. Whether students have access to a computer at home or at school, it is extremely important that they have some computer access.

In order to determine which factors would facilitate *WebExpedition*'s use in the classroom, we visited Jon Jonker, Delta, St. Paul's, Combrietum, and the Namibian Institute for Special Education [NISE] and viewed the computer labs. This enabled us to gain a much better understanding of what to expect for *WebExpedition* development and use. Figure 15 and Figure 16 show the computer labs in two secondary schools in Windhoek. Interestingly, Jon Jonker Afrikaner Secondary School had better quality and more computer equipment. This was surprising because Jon Jonker is a government school located in a poorer section of Windhoek. In contrast, St. Paul's College, a private school, is much more affluent, and is considered one of the top three secondary schools in all of Windhoek. The NISE had a much different computer lab. Even though a new computer lab was being put together, their computer lab consisted of two old computers in a very small room, and one of the computers was out of order.

Visiting the schools helped us determine that computers were available in at least some of the schools, but we needed to find if students and teachers were currently using the computers. Just because a particular school has a modern computer lab does not mean that the computer lab is being used to its full potential. In an interview, the principal from Jon Jonker Afrikaner Secondary School said that teachers in his school do not use computers to teach the students. The computer lab was rarely even open to students because of security issues. There were several accounts of computers being stolen from the labs and even from teacher's classrooms. This could point to one reason why teachers do not feel comfortable using the computers; however, it is certainly not the only reason. We did not obtain actual information from the teachers at Jon Jonker but at other schools, teachers stated that they did not feel comfortable using computers because they did not have experience with using them.

FIGURE 15. JON JONKER AFRIKANER SECONDARY SCHOOL COMPUTER LAB

FIGURE 16. ST. PAUL'S COLLEGE COMPUTER LAB

In order to determine how much students are using computers, we also used the computer usage survey discussed earlier (see Appendix I). As stated earlier, this survey collected information from over 240 students from five different secondary schools in Windhoek. We believe the data are a good representation of the computer usage in Windhoek's secondary schools because of the diversity of the schools where we were able to conduct the survey. The five secondary schools where we conducted the survey included a well-funded government school (Delta), an underfunded government school (Jon Jonker), a very well funded, prestigious private school (St. Paul's), and an underfunded private school focused on serving low-income families (Combretium).

Even though the data could have been made more representative by visiting more secondary schools outside of the Windhoek area, the schools surveyed were the most feasible for us to contact given the time frame of our project. We could have tried to visit much less privileged schools in various regions across Namibia, but this would not have been as relevant to our project. Students at many of the less privileged schools do not have access to computers and certainly do not have access to the internet. Given the very tight time-frame for testing the game on students, we needed to visit schools that had students who could immediately use the game. Targeting the game towards students at less privileged schools would not have been a realistic objective because the students at these schools do not have access to computers. Even without interviewing specific students and teachers at these schools, the data that we collected from students at the schools listed in Table 2 showed us that the majority of students were not using their school's computers (See Figure 17-19).
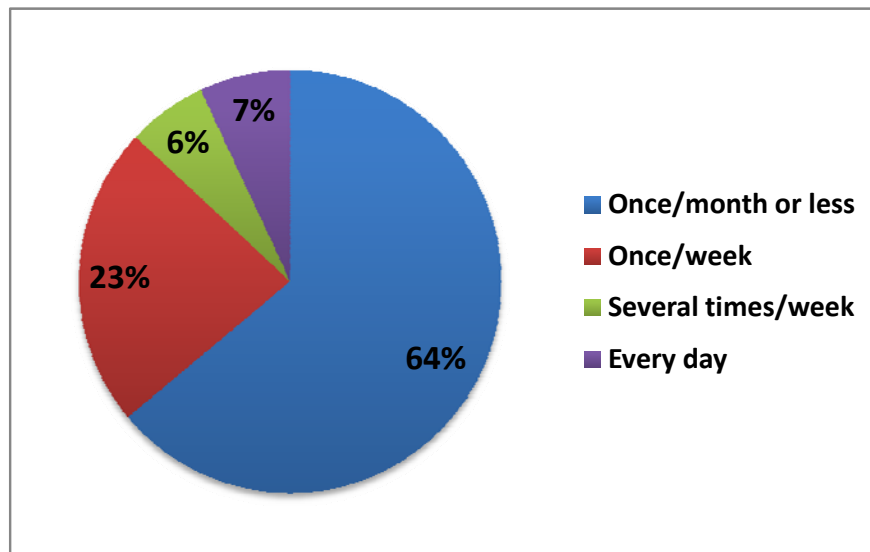
FIGURE 17. STUDENT COMPUTER USAGE AT SELECTED SECONDARY SCHOOLS IN WINDHOEK. PERCENTAGES REPRESENT DATA FROM 242 STUDENTS AT FIVE NAMIBIAN SECONDARY SCHOOLS
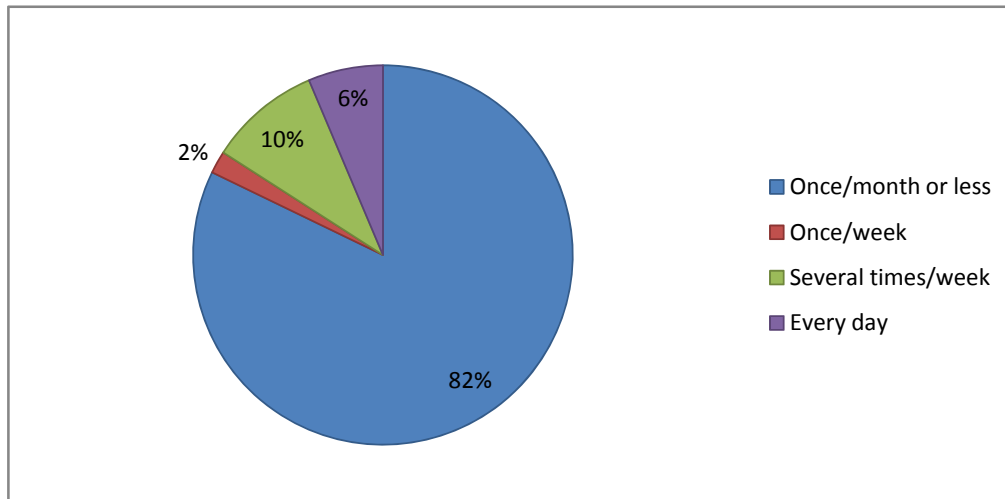
FIGURE 18. STUDENT COMPUTER USAGE AS PART OF A CLASSROOM ACTIVITY. PERCENTAGES REPRESENT DATA FROM 242 STUDENTS AT FIVE NAMIBIAN SECONDARY SCHOOLS)
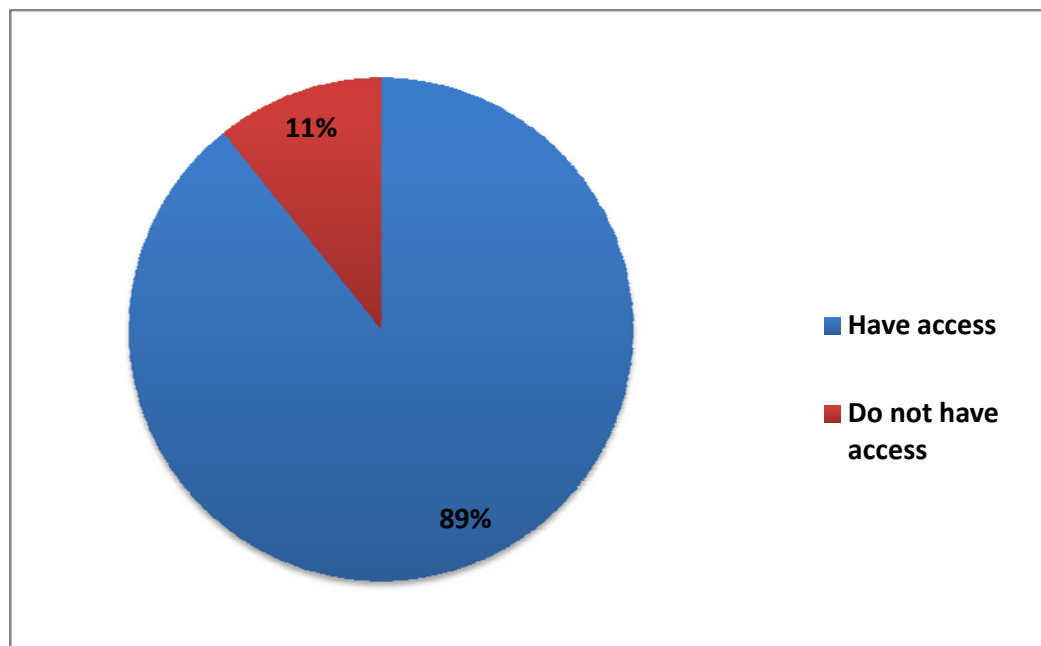
FIGURE 19. SECONDARY SCHOOL STUDENT'S ACCESS TO COMPUTERS AT HOME

From these data, we determined that students had been using computers more often as individuals outside of the classroom than as part of an actual classroom activity. However, nearly 18% of the students were still using computers once/week or more as part of a classroom activity. This reaffirmed that implementing *WebExpedition* in the classroom would still be feasible, and that it may even help increase future computer use in the classroom. Even though nearly 64% of students only used the computers at school less than once per month, there were students who were using computers more often. After collecting the data from all of the surveys, we realized that it would have been more useful to find out whether or not the

students were taking computer science classes. This would have a better representation of computer use because computer science students use their computers as part of daily classroom activities.

Through classroom observations and meeting with teachers, we determined that teachers from NISE, Jon Jonker, and Combrietum do use lesson plans to help guide them and provide suggestions to teach the students. We used this knowledge to create suggestions for *WebExpedition* use in the classroom. These suggestions can be found in Appendix U. Teachers can use these suggestions in conjunction with *WebExpedition* to introduce students to biodiversity in Namibia and the environmental issues affecting Namibia's biomes. Moreover, no teachers are obligated to follow these suggestions before having students use the *WebExpedition*. The suggestions are simply meant to demonstrate to the teachers how they can connect the material presented in the *WebExpedition* with the material that students are learning in the actual classroom.

4.4.3 Determine How the Tool Can Help Deaf Students Learn

After meeting with Heidi Beinhauer from the Association for Children with Language, Speech, and Hearing Impairments of Namibia [CLaSH], we were able to gain a much better understanding of what we needed to include in *WebExpedition* to help deaf and hearing-impaired students learn from the game. There is a difference between how the hearing impaired and the deaf learn. The hearing-impaired are able to hear and talk, but they are still hard of hearing to some degree. The deaf are those who cannot hear at all and use a type of sign language to communicate. We needed to be sure that we were using the correct terminology when interviewing teachers and students at the Namibian Institute for Special Education.

In order to make the game fully functional for deaf and hearing-impaired students, we made sure to incorporate certain ideas provided by the members of CLaSH and teachers from the Namibian Institute of Special Education [NISE]. We first knew it was going to be important to include as many visual aids as possible into the game, and therefore we created visuals to ensure that the deaf students could understand and benefit from the game. Secondly, because deaf students communicate mainly through sign language, we knew that clear and concise wording would be important. Clear and concise wording would not only benefit the deaf students, but it would also significantly benefit all users of the game.

After visiting the Namibian Institute of Special Education, it was quite clear that the students wanted to learn about science. After observing a teacher from NISE teaching a class, we found that small class size is extremely important when teaching deaf students to ensure that the students do not get distracted and that they can easily ask the teacher questions. To

view the notes from the classroom observation at NISE refer to 0. We discovered that if a particular student did not understand something or needed further explanation, the other students would try to explain to make sure that all students in the class understood the material. This helped confirm our assumption that allowing students to work on *WebExpedition* in groups may be easier for deaf students to learn effectively.

4.5 EVALUATION

In order to make *WebExpedition* as useful as possible and to analyze its effectiveness, we tested it with students. We first evaluated the initial version of the game by having students beta test it, and asked for their feedback following the testing. The beta test allowed us to determine needed improvements to make the game as playable and effective as possible. After we made the necessary changes, the game was tested again, and further evaluation was performed to understand the value of our game.

4.5.1 Ensuring Content Accuracy and Tool Functionality

The beta testing with grade nine students at Delta School yielded valuable information regarding the successful aspects, and flaws of *WebExpedition*. Students enjoyed the challenge of catching the animals as they moved across the screen. This was determined by observing their excitement as they played. In the focus groups we conducted after the students had completed playing the game, several students also explicitly stated that they really enjoyed the catching aspect of the game. Some students got more involved in the classification game than others. Some students quickly grasped the concept of classification and became engaged, while others were overwhelmed by the challenge and resorted to guessing. Students also mentioned in the focus group that the information provided about the taxons was interesting and informative.

One of our concerns was that students would not be critical enough in their feedback, but the students were in fact very honest about the flaws in the game, and potential improvements that were needed. The greatest weakness of the game at the time of testing was effectively conveying the clarity of objectives and the overall goal. Students stated that the objectives and goal were not clear throughout game play. One group of students said that the tutorials moved too slowly and did not match their pace. Another group of students moved quickly through the classification tutorial, but then displayed confusion when they began to complete the classification activity within the game.

Although the students stated that the catching game was very fun, they had difficulty catching organisms because the game did not run smoothly at expedition sites. Students also spent very little time back at their collection in the lab. It is likely that this is because there were

no substantive activities in the lab that could not be completed at an expedition site. One student, who was only sitting behind the computer looking on, said that the text was too small to see. Ensuring that those sitting around the computer looking on can easily see everything that is going on is very important because the game will likely be played in groups. In addition to these observations, we observed the ways in which the students interacted while playing the game as a group. The students enjoyed the game by playing in the group and collaborated in problem-solving, which supports the research done by Foko and Amory, 2006.

Following the tests, we were able to determine the most important things to improve in order to optimize *WebExpedition*. We also understood which aspects of the game worked well and made it successful.

4.5.2 Demonstrating Tool Effectiveness

After developing the game and making improvements based on the beta tests, we built in Avatar monitoring to monitor when students made correct and incorrect answers, as well as to monitor when students use hints and what difficulty the question they used hints on. We had ten Polytechnic of Namibia first-year students test the game, and collected data on its effectiveness.

To see if students were learning from the game, we had the Avatar monitor record the time a student answered a question correctly or incorrectly. The timer starts when the user makes his or her first attempt to answer, thus normalizing the beginning of actual play and reducing time shifts caused by the tutorials. For each two-second interval, we took all the answers from all the students and found the percent of them that was correct. As a whole, the students answered questions correctly with a higher frequency as time went on, suggesting that the students' performance generally improved. This data can be seen in Figure 20.
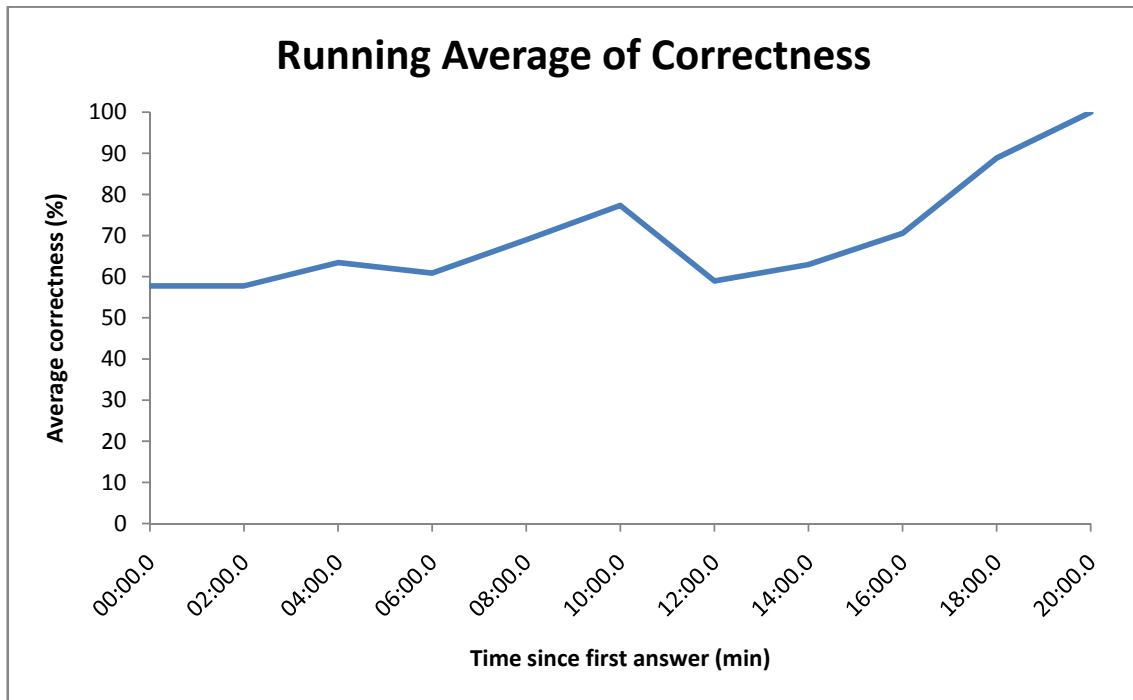
FIGURE 20. AVATAR MONITORING: CORRECTNESS OF ANSWERS OVER TIME. CORRECTNESS WAS MONITORED OVER TWO MINUTE INTERVALS.

In order to support this idea, we also monitored when students asked for hints in the game. We had the avatar monitor record when each hint was asked for, with the timer starting when the first hint was asked. We then plotted the average frequency per student per each two seconds. As can be seen in Figure 21, there was a rise followed by a decline in the frequency of hints. We believe that the initial rise is a property of the learning curve for getting used to the game, and the decline is due to an increased knowledge of students of the higher level taxons, particularly kingdom and phylum. This is supported by the average difficulty of the hints being asked, which can be seen in Figure 22. We monitored the average difficulty by having the avatar monitor record the taxonomic level being asked about, and averaging the values received from all students every two seconds. As the students play the game, they use hints primarily for lower (closer to species) level taxons, suggesting that they don't need hints for the higher level taxons.
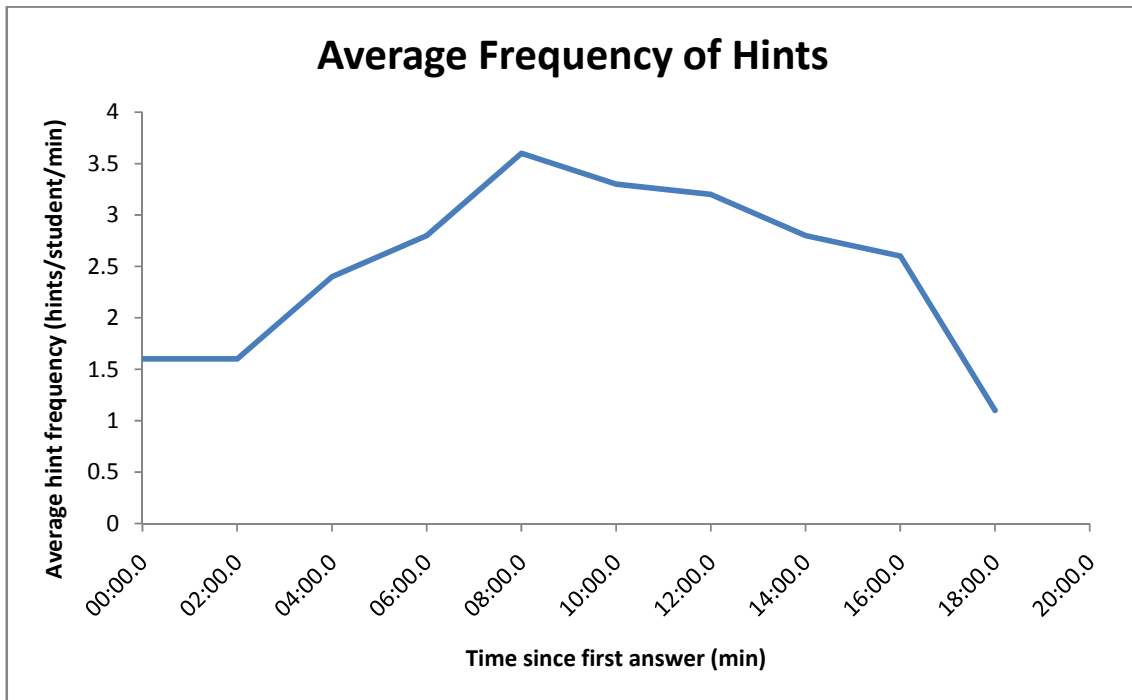
FIGURE 21. AVATAR MONITORING: AVERAGE FREQUENCY OF HINTS REQUESTED. FREQUENCIES WERE TAKEN OVER TWO MINUTE INTERVALS.
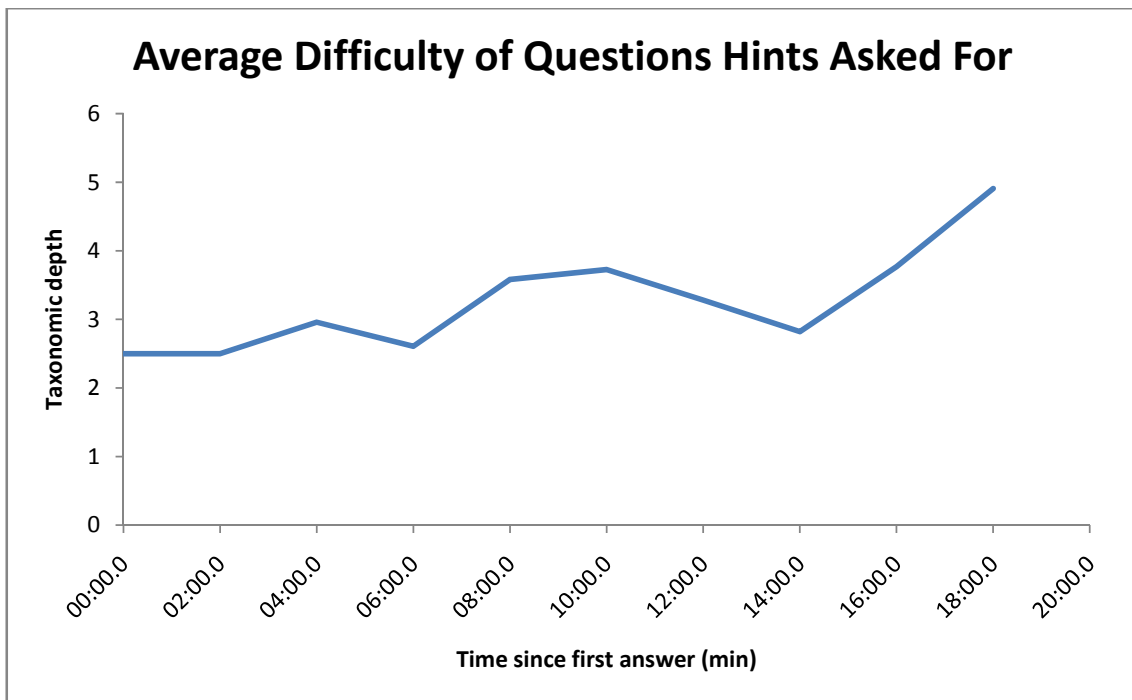
FIGURE 22. AVATAR MONITORING: AVERAGE DIFFICULTY OF QUESTIONS HINTS ASKED FOR. DIFFICULTY IS MEASURED BY THE TAXONOMIC DEPTH OF THE QUESTION: 0 IS KINGDOM, AND IS THE EASIEST. 6 IS SPECIES AND IS THE HARDEST.

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In addition to avatar monitoring, we used the EGameFlow scale to demonstrate the areas in which *WebExpedition* is particularly strong or could use improvement as an educational game. In total, the students gave the game 84.8% of the possible points. The lowest two sectors were goal clarity and autonomy, and the highest two sectors were the games ability to keep the students focused and to pass on knowledge. The sector results can be viewed in Figure 23, and the full results from the EGameFlow scale can be viewed in Appendix X.
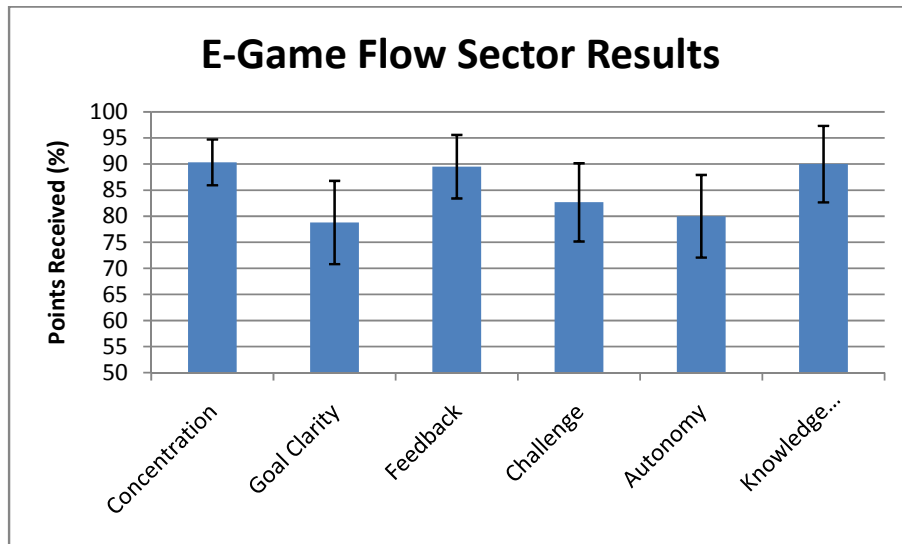
FIGURE 23. EGAMEFLOW SECTOR RESULTS. ERROR BARS SHOW STANDARD ERROR OF THE MEAN.

4.6 SUMMARY OF RESULTS

Developing a design document that enabled us to put all of our ideas on paper helped us develop *WebExpedition* in the limited time we had. Dozens of ideas were given to us from EduVentures staff, museum staff, and other researchers. Organizing them allowed us to determine which ideas we could develop and which ones were most important and create a design document. For any further improvement that EduVentures wants to do to *WebExpedition*, it will be extremely important to create a document similar to what we have created. Making it easy for future development and improvement by use of the SpeciesEnterer program will help this game stay up-to-date. SpeciesEnterer allows the addition of new organisms, which will ensure that the game will not remain static. After going through several weeks of developing *WebExpedition*, it was ready to be tested by secondary school students. This helped us to fix bugs in the game and to get any last minute feedback from the students. Through testing the game on students, we also were able to determine that the game was enjoyable for them, and that they were learning from it.

5 CONCLUSIONS AND RECOMMENDATIONS

EduVentures *WebExpedition* is a valuable educational game that students in Namibia can use to help them learn. It has opened up another way for students to learn about biodiversity in Namibia. The teachers and students affiliated with the six schools that we visited are excited about the game because it is something new and exciting that they have never experienced before. The students from the schools we worked with had varied access to computers and the internet. The majority of them had access to computers at home and at school in order to use *WebExpedition*. However, incorporating the game into the classroom in secondary schools has also required creating suggestions for classroom implementation that will help to introduce the game to students in a more integrated manner. They will help to facilitate the use of *WebExpedition* in conjunction with the biology curriculum provided by the Ministry of Education of Namibia. We have also identified ways that *WebExpedition* can be expanded and improved, as well as further suggestions about how EduVentures can expand their educational mission.

5.1 THE VALUE OF *WEBEXPEDITION*

Students and teachers are open to the possibility of using a computer game as an educational tool and want to use the game. When first presented with the idea of *WebExpedition*, students and teachers were excited at the prospect of being able to use it. In our discussions with teachers, it was clear that they were open to an interactive computer-based educational game as a teaching resource. The two teachers we worked with from NISE were especially interested in it as a supplement to their teaching resources because interactive visual aids are effective learning tools for hearing impaired and deaf students. The teachers had many ideas for content that would be useful to include in the game and showed much enthusiasm for using the game. The students whom we talked to also showed excitement for playing an educational game like *WebExpedition*.

There are opportunities for educational computer games in the Namibian school system. Although only certain schools have the equipment to be able to use an educational computer game like *WebExpedition* there are a sufficient number of schools equipped with computers to make an educational game a valuable asset for Namibian schools. We saw evidence that computer use is growing and expanding in Namibia. This suggests a trend toward more integration of computers into the classroom, which means that the possibility of implementing an educational game such as *WebExpedition* into classrooms will grow in the future.

Students and teachers feel that education about biodiversity and the environment is important. The teachers whom we worked with in Windhoek informed us that the majority of students are ignorant about their environment, and that it is an important part of their education. Students that we spoke with displayed a limited view of the importance of biodiversity. In contrast, students who had been on EduVentures expeditions showed a certain awareness and respect for nature that students do not normally possess.

5.2 USE OF THE GAME IN THE CLASSROOM

We have determined that it would be feasible for *WebExpedition* to be included in the biology curriculum. Since the topics of taxonomic classification are introduced to students during grades eight and nine, we believe that this would be the best target audience for the game. It can certainly be used for all age ranges in the secondary schools, but grades eight and nine would be the most suitable target audience because of the alignment of the game's activities with topics in the national curriculum.

Through conducting a beta test with grade nine students at Delta Secondary School, we determined that *WebExpedition* works great with groups of students. If one student could not figure something out, the other students would help. Since many of the students had not had experience with scientifically classifying animals and plants, working on the game in groups helped them to learn more from the game.

The availability of computer equipment varies from school to school. Even in schools with sufficient equipment, it is not always available to be used for classroom activities. The best time for teachers to use *WebExpedition* would be to use it after the school day is over. This would ensure that class time in computer science classes is not being affected by showing students the game.

From our survey of students we determined that out of the 243 students who were surveyed 89% of them had access to a computer at home (see Figure 19). This reaffirmed our conclusion that *WebExpedition* can be used at home if students are interested. If these students have access to the internet, they could just use the game on the web. If students do not have access to the internet at home but have a computer, the teacher could be given several copies of the game on compact discs and lend them to the students.

We created suggestions, which we sent with a hard-copy of *WebExpedition* on a CD to teachers, to help guide the teachers in using *WebExpedition* in their classrooms and in concert with the biology curriculum provided to them by the Ministry of Education. *WebExpedition* does

not have to be used in any particular manner, however—it can be an effective learning game inside the classroom and out. These suggestions can be seen in Appendix U.

5.3 RECOMMENDATIONS FOR FUTURE DIRECTIONS

In order for *WebExpedition* to continue to be valuable, we suggest that it be expanded in the future. During the course of development, we identified many ideas that we were not able to implement. Many of these ideas could be easily added to the current virtual expedition, and others could be used as part of a modular group of activities based at the museum.

5.3.1 Potential Expansions to the Virtual Expedition

These ideas can be used within the current framework of the *WebExpedition* to enhance the learning experience.

- **Environmental Awareness Features**

  Features are any objects that appear in expedition sites. In these sites, the game could include features that are related to environmental issues, such as an area with a high density of desert, a deforested site, or a mining site. Clicking on these features could give the students more information on their environmental effects, or bring the students to a new mini-game. This would help the students learn more about Namibia's environments and the effects that their everyday actions can have on them.

- **Contact with Other Scientists**

  In order to show how scientists all over the world benefit from the collections at the museum, the lab could also include a cell phone or a computer, through which the user could receive messages. These messages could include requests for help classifying an organism, or allow a user to get points by sending his or her collection to the scientist. This makes the game more interactive by allowing the users to talk with each other and would provide another way for students to obtain information for classifying organisms.

- **Packing for Expeditions**

  In order to add more challenge and a sense of progression to the game, the user could be brought to an interface where he or she will have to pack for the journey. The users would have to choose how many points to spend on things like water, petrol, and vials. These would determine how far the user can go, and how many samples the user can collect. As the users amass more points, they can go closer to the corners of Namibia,

which contain more rare species, especially the Namib Desert, the Succulent Karoo, the Caprivi Strip, and the Kalahari Desert.

- **Animated Animals**

    In order to increase the visual appeal of the game, animals could be animated. This could be done by animal type, where animals that move similarly could use the same basic animations. In addition, the movement of different animals could be made more complex. Different animals could, for instance, attempt to hide behind a nearby plant.

- **EduVentures Staff Appearances**

    In addition to instructions from Tauno, an EduVentures participant, the user could also receive guidance from Tharina Bird or Benson Muramba, two of the actual staff at the museum. These pedagogical agents could add a more expert feeling to the advice given, as well as introduce the students to people important to EduVentures and the museum.

- **Additional Environments and Species**

    Because of their small area compared to the other major biomes, the shoreline, Etosha Pan and the Caprivi Strip were not included. Students expressed a lot of interest in marine animals and animals unique to these areas . We therefore suggest that these areas be added in the future.

5.3.2 Other Ideas for *WebExpedition*

These ideas can be added as modular parts to the *WebExpedition*. We suggest that as the game grows, more of the museum's research facility is shown, and the user will be able to see more of this building. From different places, the user will be able to access different games.

- **Solifuge and other Species Games**

    Because solifuges are the topic of much mythology, a solifuge game may be extremely popular and help educate people on these exciting organisms.

- **Biodiversity Garden**

    The National Museum of Namibia maintains a sustainable garden, which could be used as a focus point for teaching about biodiversity and sustainable living.

- **Lab Equipment Safety**

    As a means of teaching students more about laboratory conditions, a mini-game focusing on laboratory safety may be used.

- **City Game**

In order to teach students more about environmental issues that affect their country, we suggest a game that takes place in a city. Here the students may learn about the effects of urban development and pollution through either planning the city or some other activity.

- **San Village Mini-game**

The traditional lifestyle of the San is in tune with the environment, and many students are unaware of the San's age-old traditions of sustainability and respect for the world around them. A game involving the San could be a vessel into learning about sustainability, as well as some of the country's heritage. It could also help the San gain more respect from other Namibians, something that they do not have right now.

5.3.3 Additional Recommendations for EduVentures

- **Market *WebExpedition***
Since most secondary school students could benefit from playing *WebExpedition* it should be marketed to a larger target audience. We were only able to visit six secondary schools in Windhoek, but would have liked to visit more. Many more schools in Windhoek could benefit from the game and many schools in other parts of Namibia could benefit from the game. This would help to increase student's knowledge about Namibia's biodiversity and environment but would also assist in disseminating information about EduVentures and the National Museum of Namibia to the public.

- **Make *WebExpedition* more Usable for Deaf Students and More Easily Understood**
We initially had the idea of making the game easy for deaf students to play, but realized that this was more difficult with the amount of time that we had to develop the game. The game has some visuals that would allow the students to learn from *WebExpedition*, but it could certainly include a more systematic method of visuals and maybe even have some symbols from the Namibian standard sign language. Working more with CLaSH and NISE would be a crucial step towards making the game more usable for deaf students. In addition, the EGameFlow scale revealed that the greatest weaknesses of the game were in the students' abilities to understand the game goals and instructions. Steps towards making the game more understandable by deaf learners would also help support these areas of the game.

- **Printed Version of *WebExpedition***

A printed version of *WebExpedition* would ensure that students enrolled in schools in remote areas of Namibia would be able to access the game. Since a lot of these schools most likely do not have computer or internet access, an altered printable version of *WebExpedition* would help more secondary school students across Namibia learn about their country's environment and biodiversity.

- **Field Trips to Research Facility**

  The research facility at the National Museum of Namibia has many interesting labs and rooms containing collections that students could learn from. There is a room dedicated towards collecting and analyzing the skulls of various animals around Namibia, and a room filled with vials and jars of various specimens that were collected on actual EduVentures Expeditions. The students would find this very interesting and could boost their interest in expeditions as well as give them a firsthand experience at a part of the museum that is not commonly experienced by the public. The researchers at the museum are extremely knowledgeable and can serve as a resource of information for the students.

5.4 SUMMARY

Computers are a viable tool for educational purposes in Windhoek secondary schools. Computer use in schools and in general is growing in Namibia. We have found that for many students in the Windhoek area, computers are available in their schools. These students and their teachers are interested in using educational games. Teachers should be given opportunities to use computer games that will help teach their students the basics of how to use a computer as well as be a fun way to learn other topics. Many students in Namibia, especially in the Windhoek area, never get the chance to experience biodiversity firsthand. Biodiversity could be taught using computer games. Therefore, we have created a game that can teach students about biodiversity while also teaching them about how research is done at the National Museum of Namibia. This game can be changed and expanded, and we have provided a list of suggestions of ways the game could continue to be developed. This game can be used to supplement the current curriculum of eighth and ninth graders, and should provide a fun way for them to learn.

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GLOSSARY

Adobe Flash – Computer software that allows the user to create drawings, animations, and websites in an interactive manner.

ActionScript – This is a programming language majorly used with Adobe Flash software. Allows the user to create interactive computer games and websites.

Beta Test – Term used for testing a computer or video game after its complete development. The development team "beta tests" the game in order to find out specific problems that the audience may encounter when using it.

Biodiversity – Biodiversity is all of the genetic variation of organisms in an area (Moulton & Sanderson, 1999). With as many as 30 million species, planet Earth has a vast amount of biodiversity available. Biodiversity does not simply refer to the number of species, however, but also to the variations within that species. Aside from the aesthetic appeal of a diverse planet, biodiversity is a major natural resource.

Biomes – Biomes are areas of the world that make up ecosystems. Biomes can be characterized by their plant species and vegetation structures. In Namibia, there are four biomes: Desert, Nama-Karoo, Savannah, and Succulent Karoo.

The Association for Children with Language, Speech and Hearing Impairments of Namibia (CLaSH) – A welfare organization that offers resources for children with language, speech, and hearing disabilities. Some of their services include provision of hearing aids, assessments, and speech and language therapy.

Desert Research Foundation of Foundation (DRFN) - The DRFN is a non-govnernmental organization aiming to provide research and resources to help create sustainable development in Namibia. It is divided up into three sectors: Water Desk, Land Desk, and Energy Desk.

Design Document - This is a document that helps outline the development and progress of software programs.

EduVentures (Sponsoring organization for this project.) –An educational outreach program that provides students with the opportunity to go on expeditions into the Namibian wilderness and collect samples for the National Museum of Namibia. (For more information see Appendix A.)

Interface – This is the means in which a user interacts with a device, machine, or computer. Allows the user to input data and extract data from the device.

Nama Karoo – A biome in Namibia that has low summer rainfall and contains plant life forms such as shrubs and perennial grasses. This region has a harsh climate and often has droughts.

Namibian Institute for Special Education (NISE) - A school in Windhoek geared at teaching students with disabilities. This school is affiliated with EduVentures and is one of the schools that we visited and interviewed teachers from.

National Botanical Research Institute of Namibia (NBRI) – This research institute is based in Windhoek and focuses on the plant species found in Namibia. They help the public learn more about Namibian plants by providing a public library and its own sustainable garden for public viewing.

Pedagogical Agent – These are animated images of people to help the users of a game or specific tool learn more effectively. They are guides that help in the learning process.

SpeciesEnterer – A program created for this project that facilitates the addition of new content to *WebExpedition* without the necessity of programming.

Succulent Karoo – A biome in Namibia and South Africa. It is known for its variety of plants, especially succulents, which are plants with fleshy stems and leaves. Based on the high plant diversity and the many plant species that are endemic to the area, the Succulent Karoo has been named by scientists as one of the world's 25 most important and diverse biodiversity areas in need of protection.

Taxonomy - Taxonomy is the science and practice of classification. This report talks about taxonomy in the specific context of classifying organisms.

Unified Modeling Language (UML) – A tool used to model and organize the components of software programs.

***WebExpedition* -** The web-based educational computer game for Namibian students created for this project.

Worcester Polytechnic Institute (WPI) – A tertiary learning institution in central Massachusetts, in the United States.

eXtensible Markup Language (XML) - A programming language that is effective at storing and sharing structured data

APPENDIX A. SPONSOR SUMMARY

EduVentures is a non-profit organization which is run from within the National Museum of Namibia. It was founded by Nicholas Krone, a secondary school teacher, and Tharina Bird, a curator of the National Museum of Namibia (Mapfumo & Vollbrecht, 2008). In 2003, seven students from Immanuel Shifidi Secondary School, in Windhoek, were guided by museum staff to the Namib Desert to collect specimens for the museum. After the success of this trip, EduVentures was born (EduVentures, n.d.). Initially, the organization was run solely on private donations. The museum contributed office space, and their faculty to the operation. EduVentures grew and became more successful, despite limited funding, and eventually they applied to become an official Non-Governmental Organization. EduVentures is now registered as a trust, and operates with a Board of Trustees. The EduVentures website lists the Global Environment Facility, The Rössing Foundation, and The National Museum of Namibia as sponsors (Mapfumo & Vollbrecht, 2008).

Holger Vollbrecht is the program coordinator, as well as the designer of the EduVentures website (Mapfumo & Vollbrecht, 2008). EduVentures has a Board of Trustees, but the only specified member on the board is Benson Muramba, who is also a technician at the National Museum of Namibia.

The mission of EduVentures is to give the opportunity for secondary school students in Namibia to experience the environment in ways that their circumstances would not otherwise allow (Mapfumo & Vollbrecht, 2008). The students go on expeditions, on which they collect samples of the biodiversity of Namibia, increasing the scientific knowledge of the museum. These expeditions will benefit the students by providing them with leadership training and knowledge that gets them interested in science. The country benefits from students who feel invested in their environment and will grow up to make decisions that will support sustainable development. Expeditions from EduVentures have given significant and lasting experiences to the students. Participants in the program have presented their projects abroad, gotten scholarships, and found work.

The samples found have greatly expanded the biodiversity knowledge of Namibia, and one of the samples even supported the discovery of a new genus of spider in Africa (Platnick & Bird, 2007). Perhaps the most significant discovery of the program was the presence of the Gladiator in the Fish River Canyon, an insect thought to be extinct until 2002 (Travel News Namibia, 2006). The three students, including one deaf student, found the experience extremely valuable (Godwanna News, 2007).

There are several other organizations in Namibia that are also working to ensure that the Namibian youth are becoming educated to understand pertinent environmental issues. An independent program, Children in the Wilderness, provides an opportunity for underprivileged children to take part in learning programs focused on the environment (Robin, 2006, p.38). It also has intentions of allowing these children to achieve goals that they would have never been able to reach on their own. "The main goal of Children in the Wilderness [CITW] is to help these young Namibians cope with life's challenges and to educate, empower and inspire them to be all that they can be. All of this, while creating a legacy of conservation" (Robin, 2006, p. 38). EduVentures does not put as much emphasis on strictly educating orphaned and vulnerable children in rural environments as CITW, but the underlying goals of the two organizations overlap.

Another organization working hands on with the National Museum of Science is Insect@thon (Powledge, 2002). Insect@thon works to teach Namibian students about biodiversity through having them analyze and input data into digital computer databases. The schools that participate are eligible to receive prizes and access to internet connectivity and computers. This program not only provides some background on biodiversity, but also enables these students to receive access to the internet. "Insect@thon since has spun off an organization called School Net Namibia, which provides schoolchildren with computers for a variety of projects" (p. 1078).

School Net Namibia (2007) is an organization looking to empower young Namibians through internet access and use of technology. "The Namibian government recognizes School Net Namibia as a key player ... in education and job creation, toward its National Development Plans for 2000-2010" (Home section, para. 4). School Net is not affiliated with EduVentures, but as our project team moves forward it will be imperative to make sure that students have internet access. Contacting School Net and letting them know about our plans to create this web-based interactive game could potentially help spread the word about EduVentures, thus allowing more students to use our web-based game.

There are dozens of other outreach and environmental education organizations in Namibia that support teaching young Namibians about environmental issues and helping them understand how their actions today can affect future generations of Namibians. These organizations can be found on the Namibian Environmental Directory website. None of these organizations are affiliated with EduVentures. One of the most noteworthy organizations found on the website is the Michelle McLean Children Trust, which educates young Namibians about the environment to help prepare them to be ready for their future (Namibian Environmental Education Network, 2006).

EduVentures works hand in hand with many science, education, and development organizations. The Namibian Biodiversity Database provides biodiversity information and technology to Namibians in hopes that it will increase the general public's knowledge on the subject matter (Mapfumo & Vollbrecht, 2008). The Namibia Nature Foundation [NNF] works toward a similar cause; the NNF works to "promote sustainable development, the conservation of biological diversity and natural ecosystems" (Science, Education & Development, para. 2).

Since EduVentures runs as a non-profit organization, it relies heavily on funding in order to maintain its current operations. EduVentures and the National Museum of Namibia work closely together to ensure that the biodiversity program is running well. The supplies and equipment for the field studies and trips put on for the Namibian students are sponsored by organizations such as the Rössing Foundation and Namibia's National Biodiversity Programme (Honey, 2003). Other funding and grants come from the National Museum of Namibia and the Global Environment Facility (Mapfumo & Vollbrecht, 2008).

EduVentures can and does provide people and information but these can only go so far in the absence of sufficient funding. The organization simply does not have enough money coming in from its sponsors to expand its programs as desired(Mapfumo & Vollbrecht, 2008). With a limited amount of capital it is very difficult to invest in new technologies.

APPENDIX B. THE INTERACTIVE QUALIFYING PROJECT

In 1970, Worcester Polytechnic Institute (WPI) began to overhaul its curriculum to what is now known as the "WPI Plan" (Mello, 2007). The goal of this reform was to establish "a project-based program emphasizing teamwork, communication, and the integration of technical and societal concerns." (p. 3). In addition, the administration of WPI sought to more strongly involve the students in their curricula and make them aware of humanities and social sciences (WPI, 2006). In response to these objectives, a group of professors established the Interactive Qualifying Project in 1972. In 2000, the Accreditation Board for Engineering and Technology (ABET) changed their criteria for engineering program accreditation to include the objective of teaching students about the societal issues of engineering (Mello, 2007; WPI 2006). This reform helped to reestablish the IQP and shape it into what it is today.

The IQP is a group project that focuses on the interaction between a scientific issue and a social problem. The project, although advised by faculty at WPI, is primarily researched, planned, and executed by students on the IQP team.

THE OBJECTIVES OF AN IQP AND HOW THIS PROJECT FULFILLS THEM

The 1972 report describing the objectives of the IQP are still relevant to the IQP (WPI, 2006). Although not all of these objectives are expected to be obtained from every IQP, we are working towards as many as possible. The original objectives relevant to our project are:

TO CREATE AN AWARENESS OF SOCIALLY RELATED TECHNOLOGICAL INTERACTIONS.

In the creation of an e-learning game for EduVentures, we are required to observe several socially related technological interactions, particularly those involved in computer use in classrooms in Namibia. Students will not be able to access the site at home, and therefore it will be essential to be aware of how teachers react to computer use, how computer use can be made possible in these classrooms, and what the benefits to computer use are.

TO CULTIVATE THE HABIT OF QUESTIONING SOCIAL VALUES AND STRUCTURES.

Some of the social values we will have to face in our project are the values centered on traditional education. Traditional educational values a one-way path of information from the teacher to the students, and is commonly practiced in schools in developing nations. We will

have to works against this grain in order for our games to be used in classrooms, and will have to find ways of fitting these games into the educational framework of Namibian schools.

TO DEVELOP AND INTEGRATE THE SKILLS OF EVALUATION AND ANALYSIS IN THE SOCIETAL, HUMANISTIC, AND TECHNOLOGICAL DISCIPLINES.

We are going to have to strictly analyze and evaluate the needs of our sponsor organization and the educators who will be using the program. We will also need to assess how effective our game is at being enjoyable and exciting students about the environment.

TO ENCOURAGE THE RECOMMENDATION OF POLICY.

One of the main factors of our project is to encourage teachers to use computers in their classrooms. As a result, we must make recommendations of how our game may be used to enhance teachers' abilities to teach their students about the environment.

APPENDIX C. BIODIVERSITY IN NAMIBIA

Biodiversity is all of the genetic variation of organisms in an area (Moulton & Sanderson, 1999). With as many as 30 million species, planet Earth has a vast amount of biodiversity available. Biodiversity does not simply refer to the number of species, however, but also to the variations within that species. Aside from the aesthetic appeal of a diverse planet, biodiversity is a major natural resource. However, the biodiversity of the planet is at great risk. Currently, we are losing species at 10,000 times the rate estimated to be natural. (SEEN, 2005) One of the primary ways to combat this destruction is through education (Moulton & Sanderson, 1999).

THE IMPORTANCE OF BIODIVERSITY

Biodiversity is essential for the health of an environment (SEEN, 2005). Biological systems need to maintain the flow and levels of resources such as phosphorous and nitrogen, as well as respond to stresses such as temperature change or water depletion. The Gaia hypothesis suggests that the biodiversity of the world is a key factor in how the earth maintains conditions in which plants, animals, and people can survive. In addition, the biodiversity of a species is critical to its ability to survive stresses such as population dynamics and disease (Moulton & Sanderson, 1999). As a population looses biodiversity, traits that may be more advantageous than others are lost. A population can enter what is known as the vortex of extinction, where slight pressures on a species wipe out nearly all of its members.

Biodiversity is also one of the largest natural resources known, able to provide many services (SEEN, 2005). Impoverished people are often completely dependent on the plant and animal species of their area for food and shelter (Branch, Stuart, Stuard, & Tarboton, 2007). Nearly all of the medicines of the world were first discovered in unique plant species (United Nations Environment Programme, & AMCEN Secretariat, 2002).The genetic resources of these plants can be used to make resistant crops.

According to the United Nations Environment Programme's report on the state of the environment in Africa (United Nations Environment Programme, & AMCEN Secretariat, 2002), "Biological resources are the backbone of the African economy" (p. 55). The people of Africa use their natural flora and fauna for many reasons. Eighty percent of Africans rely on natural, medicinal plants. In Namibia, the genetic diversity amongst herded animals such as cattle is one of the highest in the world, allowing them to boast resistant and unique strains. Ecotourism, hunting and livestock are three of the major facets of Namibia's economy (SEEN, 2005). Plants

from Namibia are currently being studied for their ability to offer drought resistance to crops (SEEN, 2005; United Nations Environment Programme, & AMCEN Secretariat, 2002).

THE BIODIVERSITY OF NAMIBIA
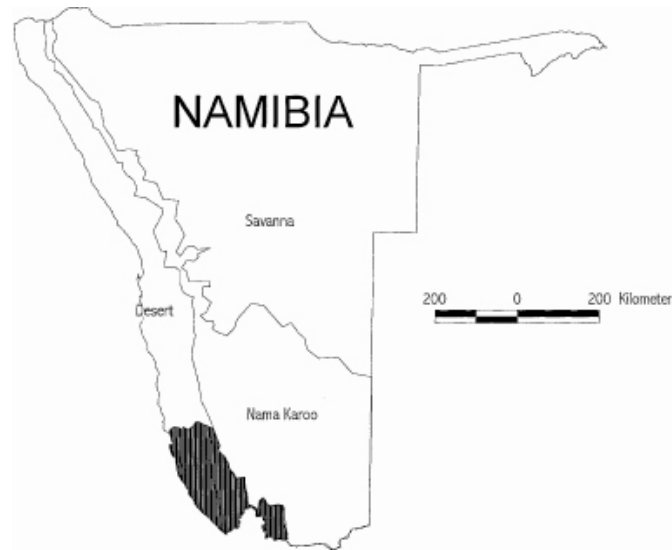
FIGURE 24. BIOMES OF NAMIBIA. THE FOUR BIOMES ARE: THE SAVANNA, DESERT, NAMA KAROO, AND THE SUCCULENT KAROO (SHOWN IN BLACK) (BURKE, 2001, P. 30).

Namibia can boast some of the most unique and diverse ecosystems in the world. The four major areas of the country as shown in Figure 24 are: the savanna, the Namib Desert, the Nama Karoo, and the Southern Namib or Succulent Karoo (Burke, 2001).

FIGURE 25. ETOSHA NATIONAL PARK. VAST PLAINS SUPPORT GAME THE GAME HERDS OF NAMIBIA (BRANCH ET AL., 2007, P. 251).

The Savanna of Namibia is the home of much of the game wildlife of Namibia. The savanna contains Etosha National Park, one of the reserves of Namibia (Branch et al., 2007). Etosha is set in the Etosha pan, which once was a giant lake. It has since dried out, however, and now consists of a large flat savanna. Etosha is a popular place for tourists to travel, but is historically been hit by Namibian poachers, for either food or money (United Nations Environment Programme, & AMCEN Secretariat, 2002).
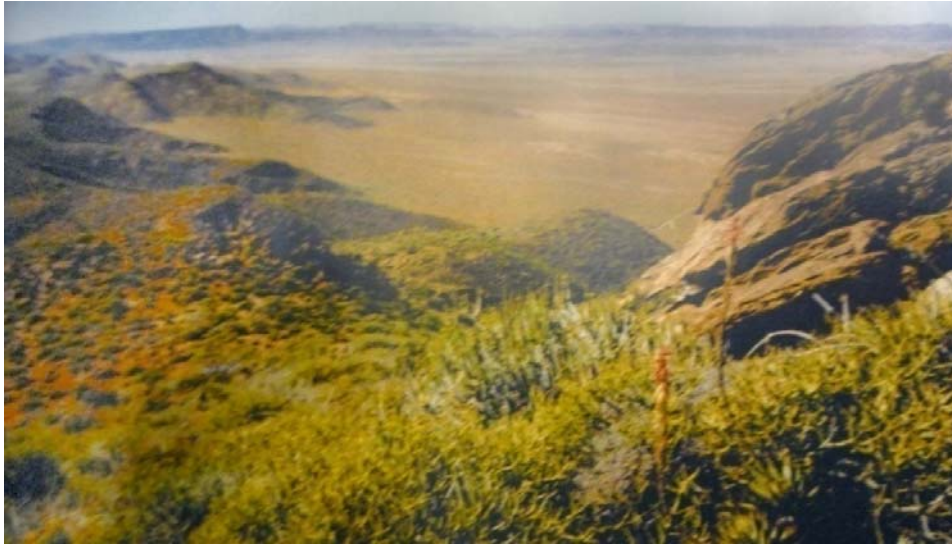
FIGURE 26. AN OASIS IN THE NAMIB DESERT. A NIGHTLY FOG PROVIDES MOISTURE TO A UNIQUE VARIETY OF PLANT LIFE (BRANCH ET AL., 2007, P. 241).

The Namib Desert is one of the unique deserts in the world. It is one of the oldest true deserts known (Branch et al., 2007). For about one third of the year, the Banguela Current off Antarctica inspires a cold fog that can travel inland. This fog condenses onto rocks and a unique variety of plant life that cannot be found anywhere else in the world. In addition to these traits, the Namib can also boast the largest dunes to be found on the planet. Namib-Naukluft Park and Skeleton Coast Park can be found in this area.

The Namib Desert is also one of the biomes most at risk. In the heat of December, people flock to the much cooler shores (SEEN, 2005). These people leave a mark in the form of litter, a problem which gets worse every year. Another draw for tourists is the giant dunes. These dunes are heavily trafficked by both man and machine. This traffic is killing plants established on the dunes, destroying ecosystems that take hundreds of years to be established.

FIGURE 27. A SUCCULENT KAROO. THE SUCCULENT KAROO BIOME FEATURES AN INCREDIBLE BIODIVERSITY AND IS ONE OF THE MOST UNIQUE BIOMES IN THE WORLD (BRANCH ET AL., 2007, P. 240).

The Succulent Karoo, which Namibia shares with South Africa, is one of 25 internationally recognized biodiversity hotspots in the world (United Nations Environment Programme, & AMCEN Secretariat, 2002). The fog that supports the Namib Desert condenses here and supports this biome's five thousand species. Of these, about forty percent of the species are endemic, meaning that they are found nowhere else. This environment contains some unique species, including its namesake karoo and lichen fields (Branch et al., 2007).

NAMIBIAN ENVIRONMENTAL HISTORY

In order to understand causes and solutions to environmental issues, it is essential to understand the history behind these issues (Moulton & Sanderson, 1999). Tribal beliefs of many African nations have reinforced an environmental outlook (United Nations Environment Programme, & AMCEN Secretariat, 2002). Offenses against the environment were often taboo, and thought to cause disappearances into the forest.

After the abolition of the slave trade, Europeans stormed into Africa in order to take advantage of resources that they believed be unclaimed. During the German colonial period in Namibia, prospectors did massive screens for diamonds, rendering vast sections of the Namib Desert unviable (Burke, 2001). Throngs of Africans were displaced from their native homelands in order for game parks to be established, introducing poverty and extreme overhunting (SEEN, 2005).

FIGURE 28. COLONIAL DIAMOND SCREENS. COLONIAL MINING PRACTICES LEFTS VAST STRETCHES OF THE NAMIB DESERT UNVIABLE (BURKE, 2001, P. 29).

When apartheid was abolished and the nations of Africa began to achieve independence, there was an amplification of pan-African pride (United Nations Environment Programme, & AMCEN Secretariat, 2002). The leaders of countries recognized the important value of the biodiversity of Africa, and joined several United Nations (UN) resolutions. When Namibia gained its independence in 1990, it wrote the following into Article 95 of its constitution: "The State shall actively promote and maintain the welfare of the people by adopting … policies aimed at … the maintenance of ecosystems, essential ecological processes and biological diversity of Namibia" (The Constitution of the Republic of Namibia). To this effect, Namibia has signed the Endangered Species Act and established the Ministry of Environment and Tourism and the National Botanical Research Institute (SEEN, 2005).

THREATS TO BIODIVERSITY

The biodiversity of the world is being depleted at an alarming rate. In some areas, it is estimated that a species is lost forever every day (Moulton & Sanderson, 1999). It is widely accepted that there are four main factors that cause extinctions known as Diamond's Evil Quartet (Caughley, 1994; Moulton & Sanderson, 1999). The four are: overkill, habitat destruction and fragmentation, introduced species, and chains of extinctions. Of particular importance in Namibia are overkill, introduced species, and habitat destruction (Branch et al., 2007; SEEN, 2005).

In the case of overkill, populations are depleted at rates that far exceed their reproductive rate (Caughley, 1994; Moulton & Sanderson, 1999). Slowly reproducing species

are at particular risk of overkill. In Namibia, increasing pressure for exports and poverty have increased the number of game animals illegally hunted (United Nations Environment Programme, & AMCEN Secretariat, 2002). In addition, the large reliance of people on plants for medicinal uses targets the plants for overharvesting.

Introduced species can have a devastating effect on an area (Caughley, 1994). Introduced species are often not targeted by any of the selective forces that keep their populations low in their natural habitats. In their new location, the species consume large amounts of resources and other species, creating areas devoid of other life. It is particularly difficult in African nations to prevent such infestations as the resources at their borders are very limited (United Nations Environment Programme, & AMCEN Secretariat, 2002).

FIGURE 29. MINING IN THE DESERT. THE LANDSCAPE OF THE SOUTHERN NAMIB DESERT IS BEING TORN UP BY MINING PRACTICES (BURKE, 2001, P. 3

Habitat destruction is perhaps the single largest risk to native species in Africa (United Nations Environment Programme, & AMCEN Secretariat, 2002). Habitat destruction rarely occurs at the borders of an environment; rather, dead spots arise within natural systems over time and can easily be seen from time-lapse satellite pictures (Caughley, 1994). This patchwork destruction not only reduces the amount of space a species can survive in, but spreads the species out and separates members from each other. The effects can be devastating on a population's ability to reproduce and to maintain diversity within the species. In Namibia, mining for precious minerals is carving up sections of the desert, eliminating life from certain areas (Burke, 2001).

Republic of Namibia

MINISTRY OF EDUCATION

NAMIBIA SENIOR SECONDARY CERTIFICATE (NSSC)

BIOLOGY SYLLABUS

ORDINARY LEVEL

SYLLABUS CODE: 4322

GRADES 11 - 12

FOR IMPLEMENTATION IN 2006
FOR FIRST EXAMINATION IN 2007

DEVELOPED IN COLLABORATION WITH
UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Republic of Namibia

MINISTRY OF EDUCATION

NAMIBIA SENIOR SECONDARY CERTIFICATE (NSSC)

BIOLOGY SYLLABUS

ORDINARY LEVEL

SYLLABUS CODE: 4322

GRADES 11 - 12

1.   **INTRODUCTION**

The Namibian Senior Secondary Certificate of Education (NSSCO) syllabus for Biology is designed as a two-year course leading to examination after completion of the Junior Secondary Certificate. The syllabus is designed to meet the requirements of the Curriculum Guide for Formal Senior Secondary Education for Namibia and has been approved by the National Examination, Assessment and Certification Board (NEACB).

The National Curriculum Guidelines, applicable at the stage of senior secondary education (Grades 11 and 12) and at equivalent stages of non-formal education, as a part of life-long learning, recognise the uniqueness of the learner and adhere to the philosophy of learner-centred education.

The Namibian National Curriculum Guidelines:
- recognise that learning involves developing values and attitudes as well as knowledge and skills;
- promote self-awareness and an understanding of the attitudes, values and beliefs of others in a multilingual and multicultural society;
- encourage respect for human rights and freedom of speech;
- provide insight and understanding of crucial global issues in a rapidly changing world which affect quality of life: the AIDS pandemic, global warming, environmental degradation, distribution of wealth, expanding and increasing conflicts, the technological explosion and increased connectivity;
- recognise that as information in its various forms becomes more accessible, learners need to develop higher cognitive skills of analysis, interpretation and evaluation to use information effectively;
- seek to challenge and to motivate learners to reach their full potential and to contribute positively to the environment, economy and society.

Thus the Namibia National Curriculum Guidelines should provide opportunities for developing essential skills across the various fields of study. Such skills cannot be developed in isolation and they may differ from context to context according to a field of study.

The skills are:
- Communication skills *
- Numeracy skills *
- Information skills *
- Problem-solving skills *
- Self-management and competitive skills *
- Social and cooperative skills
- Physical skills
- Work and Study skills *
- Critical and creative thinking skills*

The skills marked with an * are relevant to this Syllabus

2.   **RATIONALE**

Learning experience in the natural scientific area aims at increasing the learners' knowledge and understanding of the physical and biological world of which they are a part. This includes understanding how people use the natural environment to satisfy human needs, and how the environment may be changed in ecologically sustainable ways. Critical thinking, investigating phenomena, interpreting data, and applying knowledge to practical (experimental and investigative) skills and abilities are essential to understanding the value and limitations of natural scientific knowledge and methods, and their application to daily life. The application of scientific knowledge and attitudes to health is of special relevance for the individual, the family, and society as a whole.

The overall aim of the syllabus is to equip learners with the necessary knowledge, skills and attitude that will enable them to enter tertiary education or the world of work.

3.   **AIMS**

The aims of the syllabus are the same for all learners. These are set out below and describe the educational purposes of a course in Biology for the NSSCO examination. They are not listed in order of priority.

The aims are to:

1.   provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all learners, whether or not they go to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to
     1.1   become confident citizens in a technological world, to take or develop and informed interest in matters of scientific importance;
     1.2   recognize the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life;
     1.3   be suitably prepared for studies beyond the NSSCO level in pure sciences, in applied sciences or in science-dependent vocational courses.

2.   develop abilities and skills that
     2.1   are relevant to the study and practice of Biology;
     2.2   are useful in everyday life;
     2.3   encourage efficient and safe practice;
     2.4   encourage effective communication.

3.   develop attitudes relevant to Biology such as
     3.1   concern for accuracy and precision;
     3.2   enquiry;
     3.3   initiative;
     3.4   integrity;
     3.5   inventiveness;
     3.6   objectivity.

4.   stimulate interest in, and care for, the environment.

5. promote an awareness that:
   5.1 scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals;
   5.2 the study and practice of science is subject to social, economic, technological, ethical and cultural influences and limitations;
   5.3 the applications of science may be both beneficial and detrimental to the individual, the community and the environment;
   5.4 science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal.

4. LEARNING CONTENT

NOTE:

1. The learning content outlined below is designed to provide guidance to teachers as to what will be assessed in the overall evaluation of learners. They are not meant to limit, in any way, the teaching programme of any particular school.

2. The learning content is set out in three columns.
   (a) Topics
   (b) General Objectives
   (c) Specific Objectives

3. A **Topic** refers to those components of the subject which learners are required to study. The **General Objectives** are derived from the topic and is concerned with the general knowledge, understanding and demonstration of skills on which learners will be assessed. The **Specific Objectives** are the detailed and specified content of the syllabus which will be assessed.

4. Suggestions for practical activities **or** demonstrations **that are considered essential**, and which all learners should be exposed to, as preparation for the Applied Practical Skills examination (assessed by the national examination at the end of Grade 12), are included at the end of each topic.

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SECTION I   CHARACTERISTICS AND CLASSIFICATION OF LIVING ORGANISMS (5% of teaching time)

TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
1. **Characteristics of living organisms**	• Know the characteristics of living organisms	• list and describe the characteristics of living organisms • define the terms nutrition, excretion, respiration, sensitivity, reproduction, growth and movement
2. **Classification and simple keys)**	• Know and use a classificatory system	• outline the use of a hierarchical classification system for living organisms • classify living organisms into kingdoms, orders, classes, families, genera and species • define and describe the binomial system of naming species • use simple dichotomous keys based on easily identifiable features
3. **Diversity of living organisms**	• Understand the diversity of organisms and their adaptations to different environments, to be illustrated by Namibian examples wherever possible	• list the main features used in the classification of the following kingdoms: prokaryotes, protoctists, fungi, plants and animals • outline the structure of a virus, and consider the arguments for and against the classification of viruses as living organisms • list the main diagnostic features used in the classification of the following groups, using visible, external characteristics only and their adaptation to the environment: flowering plants (monocotyledons and dicotyledons using seeds, flowers, leaves and roots); molluscs; annelids; and arthropods (insects, arachnids, crustacean and myriapods) • describe the externally visible diagnostic features of the following classes of vertebrates (fish, amphibians, reptiles, birds and mammals) and their adaptation to the environment as appropriate

Suggestions for practical work or demonstrations:
- *use and/or devise a key to identify six locally occurring organisms, for example trees, insects*
- *observe and draw organisms found locally, concentrating on diagnostic features and/or features that adapt them to their environment*

SECTION II – ORGANISATION AND MAINTENANCE OF THE ORGANISM (60% of teaching time)

TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
1. The microscope	• Know how to use a simple light microscope	• identify and state the functions of the different parts of a simple light microscope
2. Cell structure and organisation	• Know and understand the cellular nature of all living organisms	• describe the structure of a prokaryotic and eukaryotic cell • identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell), as seen under a light microscope • relate the structures seen under the light microscope in the plant cell and in the animal cell to their functions • describe the differences in structure between typical animal and plant cells

3. Levels of organisation	• Realize that cells are modified for a specific function	• define tissue as a group of similar cells working together to perform a particular function
		• relate the structure of the following to their functions and locations:
		    ciliated cells – in respiratory tract and oviduct
		    root hair cells – absorption
		    xylem vessels – conduction and support
		    muscle cells – contraction
		    red blood cells – transport
		• define organ as a group of different tissues working together to perform a particular function
		• define an organ system as a group of organs performing several closely related functions, as illustrated by examples covered in Sections II and III

Suggestions for practical work:
- *use and manipulate a simple light microscope*
- *make temporary slides of plant and animal cells (for example: epidermal cells from a leaf or an onion, epithelial cells from the trachea of a sheep or human cheek cells), make observations and drawing of cells as seen under a light microscope*
- *observe, interpret and draw prepared slides of a variety of plant and animal tissues (for example: palisade layer in a leaf, epithelium of mammalian trachea)*

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TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
6.2 Plant nutrition		
6.2.1 Leaf structure	• Know the structure and function of the parts of the leaf	• identify the cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section, and demonstrate the significance of these features in terms of functions, i.e. distribution of chloroplasts for photosynthesis; stomata and mesophyll cells for gaseous exchange; vascular bundles (xylem and phloem) for transport
6.2.2 Mineral requirements	• Consider the importance and deficiency effects of certain minerals on plant growth	• describe the importance of nitrate ions for protein synthesis and magnesium ions for chlorophyll synthesis • explain the effects of nitrate ion and magnesium ion deficiency on plant growth
6.2.3 Photosynthesis	• Realize that photosynthesis is the fundamental process by which plants manufacture simple sugars from raw materials	• define photosynthesis as a process by which light energy is trapped by chlorophyll in chloroplasts and used to reduce carbon dioxide to form carbohydrates • state the balanced equation for the production of simple sugars and oxygen (either words or symbols) • describe the intake of the raw materials, the trapping and storing of energy (conversion of light energy into chemical energy, the formation of food substances and their subsequent storage (no detail required)) • define the term limiting factor and interpret (as limiting factors that affect photosynthesis) the effects of light intensity and carbon dioxide concentration on the rate of photosynthesis • explain the use of carbon dioxide enrichment, optimum light and optimum temperatures in greenhouse systems

Suggestions for practical work:
- *investigate the effects on starch production of absence of light, chlorophyll and carbon dioxide*
- *design and/or carry out experiments to investigate the effect of varying light intensity and/or wavelength on the rate of oxygen production by water weed*
- *separate the different pigments in leaves using paper chromatography*
- *investigate the effects of lack of nitrogen, magnesium and iron on the growth of green plants*
- *observe, draw and interpret prepared slides of transverse sections through a leaf*
- *make temporary mounts of the upper and lower epidermis, or epidermal impressions (using nail varnish) of a leaf*

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TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
11. Coordination and response	• Realize the importance of being able to detect and respond to internal and external stimuli	
11.1 Coor-dination in plants	• Understand the role of natural and synthetic plant growth substances	• define plant growth substances as chemicals that affect the activities of particular cells and organs • describe the chemical control of plant growth by auxins • describe the use of plant growth substances in food production (ethane and auxins) • describe the effects of synthetic plant growth substances used as weedkillers • define and distinguish between geotropism and phototropism • describe geotropism and phototropism in terms of auxins regulating differential growth

Suggestions for practical work:
- *observe and interpret the appearance of seedlings grown in uniform, one-sided and no light*
- *investigate the effects of applying auxin to coleoptiles*

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TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
12. **Homeostasis**	• Recognise the importance of maintaining a constant internal balance in living organisms	• define homeostasis as the maintenance of a constant internal environment • discuss the general role of negative feedback on homeostasis • distinguish between ectothermic and endothermic animals • list ways of temperature regulation in ectothermic and endothermic animals • describe temperature regulation, and explain the effects of sweating, vasodilation and vasoconstriction only • describe the control of the glucose content of the blood by the liver, and by insulin and glucagon from the pancreas

Suggestions for practical work:
- *investigate the rate of cooling of a warm body (represented by tubes containing hot water) under different conditions (e.g. large or small surface area, with wet or dry covering)*
- *investigate the effect of temperature on the rate of heart beat of Daphnia*

SECTION III – DEVELOPMENT OF THE ORGANISM AND THE CONTINUITY OF LIFE (20% of teaching time)		
TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
1. **Cell division**	• Acknowledge that cell division is important for the development of organisms and the continuity of life	• describe mitosis simply, in terms of the exact duplication of chromosomes resulting in identical daughter nuclei (details of stages are not required) • describe the importance of mitosis (asexual reproduction, growth and repair) • outline the principles and social implications of cloning • describe the production of gametes by meiosis simply in terms of halving of chromosome number leading to variation (details of stages are not required)

Suggestions for practical work:
- *observe, draw and interpret prepared slides showing mitosis in root tips*
- *prepare and stain temporary slides of root tip squashes to show mitosis*
- *observe, draw and interpret prepared slides showing meiosis in animal and/or plant tissue*

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TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
3. Growth and development	• Become aware of the fact that organisms become more complex as they grow	• define growth in terms of increase in dry mass • define development in terms of increase in complexity • describe the environmental conditions that affect germination • describe methods of measuring growth in a herbaceous plant and a mammal • discuss the advantages of different methods of measuring growth

Suggestions for practical work:
- *compare the percentage germination of seeds stored for different times or under different conditions*
- *measure and record the growth of an annual herbaceous plant from sowing to maturity, and use these results to construct and explain a growth curve*

TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
4. Inheritance	• Know that the transmission of genetic information from generation to generation leads to continuity of, and variation within, a species	
4.1 DNA and chromosomes		• state that DNA is the hereditary material and that it is contained in the chromosomes • define the terms chromosome, homologous chromosomes, haploid and diploid nuclei • define genes as a length of DNA coding for a specific protein • define alleles as alternative forms of the same gene which code for different versions of the same characteristics
4.2 Monohybrid inheritance		• define the terms genotype, phenotype, homozygous, heterozygous, dominant and recessive • calculate and predict the results of monohybrid crosses involving 1 : 1 and 3 : 1 ratios • describe the inheritance of sex in humans (XX, XY) • explain codominance and inheritance of A, B, AB and O blood groups

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TOPIC	GENERAL OBJECTIVES Learners will:	SPECIFIC OBJECTIVES Learners should be able to:
4.3 Variation		• describe continuous variation as influenced by the environment and genes as illustrated by height • describe discontinuous variation as influenced by genes as illustrated by blood groups • define mutation as a sudden random change in the genetic material of a cell • outline the effects of radiation and chemicals on the rate of mutation • describe mutation as a source of variation, as shown by Down's syndrome • describe sickle cell anaemia, and explain its incidence in relation to malaria
4.4 Selection and evolution		• define natural selection as the selection of only the best adapted organisms for survival and reproduction • define evolution as a process of change over a period of time • evaluate the importance of natural selection as a possible mechanism for evolution • describe the development of strains of antibiotic resistant bacteria as an example of natural selection • define artificial selection as the modification of species by selective breeding • describe the role of artificial selection in the production of varieties of animals and plants with increased economic importance

Suggestions for practical work:
- investigate inheritance of one or more characteristics using, for example, tomatoes, or "genetic maize", or use commercial software to simulate genetic crosses
- measure, record and interpret continuous and discontinuous variation, for example height in humans, length of leaves, mass of seeds
- investigate the effects of different degrees of selection pressure on the relative frequency of two alleles of a gene in successive generations, using beads or beans

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SECTION IV – RELATIONSHIPS OF ORGANISMS WITH ONE ANOTHER AND WITH THEIR ENVIRONMENT (15% of teaching time)		
TOPIC	**GENERAL OBJECTIVES** Learners will:	**SPECIFIC OBJECTIVES** Learners should be able to:
1. **Energy flow, food chains and food web**	• Understand the flow of energy through an ecosystem	• state that the Sun is the principal source of energy input to biological systems • describe the non-cyclical nature of energy flow • define the terms food chain, food web, producer, consumer, herbivore, carnivore, decomposer, ecosystems and trophic levels (using local examples) • describe energy losses between trophic levels, and the advantages of short food chains • describe and interpret pyramids of biomass, numbers and energy • explain that there is an increased efficiency in supplying green plants as human food and that there is relative inefficiency, in terms of energy loss, in feeding crop plants to animals

2. **Nutrient cycles**	• Understand the importance of nutrients to be cycled in the biosphere	• describe the water cycle
		• describe the carbon cycle
		• discuss the effects of the combustion of fossil fuels and the cutting down of forests on the balance between oxygen and carbon dioxide
		• describe the nitrogen cycle in terms of
		   decomposition by micro-organisms;
		   nitrogen fixation in roots;
		   the absorption of these nitrogen compounds and their conversion to proteins;
		   the role of microorganisms in decay and the return of nitrogen to the soil or the atmosphere (names of individual bacteria are not required)

3. **Population**	• Recognise the factors that affect population size and distribution	• define population as a group of organisms of a single species that live in a given area • state the factors affecting the rate of population growth for a range of living organisms • describe the importance of food supply, predation and disease (including AIDS) on population size • identify the phases of a sigmoid curve of population growth resulting from the action of a limiting factor • describe the increase in population size in the absence of limiting factors (human population growth) and the social implications of current human survival rate • interpret graphs and diagrams of human population growth

APPENDIX E. DESIGNING A GAME THAT WILL SATISFY ALL TARGET AUDIENCES

Creating an interactive learning game that will satisfy all potential project audiences can be a daunting task but an objective that this project must reach. Since EduVentures is the organization that this game will be created for, they must have say in how this project will be developed and what content should and should not be added into the game. Also, since EduVentures is partnered with 15 schools in Namibia, it will also be important to understand the current educational system and curriculum of these schools by conducting interviews with both teachers and students (H. Vollbrect, personal communication, February 3, 2009). The four first steps drafted by Patrick Dilley (2000), associate director for special projects at the Center for Higher Education Policy Analysis at the University of Southern California, portray how to best prepare for an interview (p. 1):

- Studying background information
- Analyzing interviews
- Creating and revising protocols
- Practicing self-reflective interviewing

STUDYING BACKGROUND INFORMATION

When first developing a plan to interview possible teachers and students within the Namibian school system, it will be important to understand all pertinent background information (Dilley, 2000). This background information includes how much experience the teachers have and how long they have been with the current school. This will be found by asking the principal or person in charge of the school that we plan on visiting. Interviewing in an entirely different culture and atmosphere can be very difficult and overwhelming and researching background information will also help to ease any problems that may occur when adjusting to culture shock.

ANALYZING INTERVIEWS

Analyzing other interviews is an important step at fully understanding how to conduct an interview (Dilley, 2000). Without the right preparation, an interviewer could miss out on important information that could have been collected and could also affect the interviewee in a way that changes the way that he or she answers questions. The interviewer needs to

understand how to best ask questions to guarantee that the information he or she is seeking will be collected and used in an effective manner. Analysis of the interviews that are conducted by the interviewers will allow for a much better understanding of how to elicit information about what the person does, thinks, and how and why he or she reacts in specific ways.

CREATING AND REVISING PROTOCOLS

After understanding the background information and analyzing an interview conducted by a professional, the interview protocol is ready to be created and later revised (Dilley, 2000). We will get access from a professional interview by searching online databases. Having a protocol ready and well rehearsed is essential towards a successful interview. The questions asked should help guide the information that the interviewer is trying to get.

PRACTICING SELF-REFLECTIVE INTERVIEWING

In order to conduct a very successful interview, the interviewer needs to practice interviewing in various settings and in different contexts (Dilley, 2000). Dilley (2000) explains various methods to be aware of when conducting the interview (p. 134):

- Listen to what the respondent is saying and how he or she is saying it
- Compare the results and findings with what is already known
- Compare the results and findings to the other questions listed in the protocol
- Be aware of time and prioritize the questions if running out of time
- Do not be afraid to clarify and explain in own words what something means, to help clarify information

Understanding the respondent's perspective on the topics and questions being raised is as important as any other step in conducting an interview (Dilley, 2000). In an article written by Charmaz (1991), it is clear as to the benefits that an interviewer can reap if he or she understands the respondent's perspective:

> To be effective, the interviewer must try to see the issues discussed and the immediate interaction from the respondent's perspective— that is, to adopt the respondent's role and look at the situation from his or her perspective instead of the interviewer's….Hence an interviewer must think continuously about what this conversation seems to mean to the other person. (p. 388)

APPENDIX F. INTERVIEWS WITH EDUVENTURES EMPLOYEES AND SPONSORS

GENERAL QUESTIONS ABOUT THE PROJECT

1. What do you see as the larger problem that this project is trying to solve?

2. What would be some specific goals for this project?

3. Are there any specific objectives that you see this project accomplishing in order to reach these goals?

4. What type of information do you see as most important to add into this interactive game and why?

5. Which specimens collected are going to be the most interesting to include in the game?

6. How should this information be best incorporated into the educational game?

7. Is this game intended to mimic the field studies programs that are already being practiced by EduVentures?

TARGET AUDIENCE

8. Will the main target audience be secondary school students who have participated in the EduVentures program or all secondary school students in Namibia?

9. Are there any considersations that we should be aware of when interviewing a private school teacher as opposed to a government school?

TEACHERS, STUDENTS, AND CURRICULUM

10. How willing do you think these teachers will be to incorporating this educational game into their current classroom activities?

11. What would be the best way to market the game to the teachers so that they would actually want to use the game in their classroom?

12. How do we reach the less developed schools that are not affiliated with EduVentures?

13. Do you a general idea of how familiar these teachers and students are with using computers or the internet/best way to find the information?

14. How much do you see this project going along with the current curriculum in Namibian secondary schools?

APPENDIX G. INTERVIEW PROTOCOL FOR SECONDARY SCHOOL TEACHERS IN NAMIBIA

QUESTIONS FOR INDIVIDUAL INTERVIEWS WITH TEACHERS:

DETERMINING IF CHANGE FOR CURRENT CURRICULUM IS POSSIBLE

1. What topics are covered in the current biology curriculum for secondary school students?

2. Are you given very specific guidelines to follow to meet specific standards?

3. Is there room for change with this current curriculum?

4. Which topics about biodiversity and environmental issues are most important to teach the students?

5. How could these topics best fit into the current curriculum?

6. What have you found to be the best way to teach students biology material?

DETERMINING IF TEACHER UNDERSTANDS LEARNER CENTERED EDUCATION

7. How would you define learner centered education?

8. Do you believe this is an effective way of teaching students?

9. How often do you teach in a learner-centered way?

10. How do you teach in a learner-centered way? Please provide examples.

DETERMINING THE AVAILABILITY OF TECHNOLOGY WITHIN THE SCHOOL AND THE TEACHERS LEVEL OF COMFORT FOR USING TECHNOLOGY

11. Are there any resources or materials that you currently do not have access to that you think would enable you to be a better teacher?

12. What technological resources are available to students?

13. (DEPENDS ON ANSWER TO 12) Do you believe more resources are going to be available in several years for Namibian students? If so, what type of resources?

14. (DEPENDS ON ANSWER TO 11) How are these resources being used in the current curriculum?

15. What experience do you have with using computers?

16. How comfortable do you feel with using computers?

17. What would be the main difficulties for using a computer to teach students about biology?

DETERMINING IF TEACHER UNDERSTANDS EDUCATIONAL GAMES

18. How would you define an interactive web-based educational game?

19. Would using an interactive educational game be an effective way to teaching students about environmental issues and biodiversity?

20. How could this fit into the current curriculum?

QUESTIONS FOR FOCUS GROUP INTERVIEW FOR TEACHERS:

1. What topics most interest students?

2. Which topics about biodiversity and sustainable living are most important to teach the students?

3. How could these topics best be fit into the current curriculum?

4. Why are computers valuable or not valuable teaching games?

5. How comfortable are teachers in general using computers?

6. Where do you see the future place of computers in the classroom?

7. What would you like to see in the *WebExpedition*?

APPENDIX H. FOCUS GROUP WITH SECONDARY SCHOOL STUDENTS IN NAMIBIA

1. Describe one of your favorite learning activities in school. What made it so fun?

2. Name some things you've learned in a science class that you thought were really cool.

3. What topics do you learn about in your biology class? How do you learn about them (lectures, laboratories, books, activities)?

IF labs and activities are done:

4. What kinds of labs and activities do you do?

5. Are any of the topics you learn about in science related to Namibia specifically?

6. Do you enjoy learning about the natural environment in Namibia?

7. What are some things that you know about the natural environment in Namibia?

8. What is your understanding of biodiversity? What are your feelings towards it?

9. Do you ever talk about environmental issues in school, at home? Do you discuss it as a class, or with other students?

10. What kind of environmental issues do you experience most closely?

Questions regarding computer games:

11. Have any of you played computer games before?

12. IF majority has played computer games, continue

13. What games have you played? What are they like? What was the goal of the game?

14. Did you have fun playing them? What about them made it fun?

15. Did you learn anything from playing them?

APPENDIX I. COMPUTER USAGE SURVEY FOR STUDENTS

We are creating an interactive web game for EduVentures called *WebExpedition*. The game allows you to take a virtual adventure into Namibia's natural world to discover the amazing life it contains! We would like to learn more about how you use computers in order to make it as fun and useful as possible. Please complete the following survey. Thank you for taking the time to help us out!

For questions 1 and 2, please circle the option that best answers each of the questions.

1. Do you have a computer in your home?

Yes | No

2. If you do have a computer in your home, are you able to access the internet with it?

Yes | No

3. Do you currently have access to any educational games on the computer (at school or home)?

Yes | No

4. If yes, do you feel that these games help you learn?

Yes | No

5. If no, would you like to have access to educational games on the computer to help you learn?
Yes | No

For questions 3-7, please circle the option that best describes how often you do the activities described in the questions.

6. How frequently do you use one of the school's computers?

| Once per month or less | Once per week | Several times per week| Every day |

7. How frequently are computers used as part of a classroom activity?

| Once per month or less | Once per week | Several times per week| Every day |

8. How frequently do you use a computer individually (you are the only one looking at the screen and controlling it)?

| Once per month or less | Once per week | Several times per week| Every day |

9. How frequently do you use a computer in small groups (of 2 to 3)?

| Once per month or less | Once per week | Several times per week| Every day |

10. How frequently does your teacher use a computer while the class observes?

| Once per month or less | Once per week | Several times per week| Every day |

For each statement in numbers 8-10, please circle the option that expresses how much you agree or disagree.

11. I feel comfortable using a computer by myself.

| Strongly agree | Mildly agree | Unsure | Mildly disagree | Strongly disagree|

12. I feel comfortable using a computer if I am using it with other students.

| Strongly agree | Mildly agree | Unsure | Mildly disagree | Strongly disagree|

13. I feel comfortable using a computer if I am using it with a teacher.

| Strongly agree | Mildly agree | Unsure | Mildly disagree | Strongly disagree|

APPENDIX J. DESIGN DOCUMENT

INTRODUCTION

WebExpedition is a role-playing game designed to work on platforms that support Flash. It will allow the user to do mock expeditions where they can collect biological samples in the wilderness of Namibia. The learning objectives to be fulfilled by the *WebExpedition* are:

- The user will be able to classify different organisms
- The user will be aware of the biodiversity of Namibia
- The user will be aware of the research process that goes on at the National Museum of Namibia

The whole concept uses our own ideas as well as some art and features supplied by EduVentures. WebExpeidition will be made using Flash Professional CS4.

GAME DESCRIPTION

You will be able to go on expeditions. You will start at the National Museum of Namibia's research facility. The first time you play you will complete basic training, where the concepts that will be important to your expeditions will be revealed, as well as the basic game play instruction. Starting from your lab bench, you will be able to choose where to travel from a map of Namibia. You will go to different places in Namibia and collect samples from these places. The types and concentrations of organisms that you find on expeditions depend on where you decide to travel. Being able to correctly identify these samples by their scientific classifications will give you points, and if you can identify at least the order of the sample and have a vial you will be able to bring the sample back to the museum to your lab bench .

KEY FEATURES

- Required Features
  - Save game
  - Point system
  - Classification game
  - Environments with features
    - Training course
    - Biome areas: desert, nama karoo, succulent karoo, savanna, Etosha
  - Collection
    - Further classification
  - Interface

- - - Ability to turn
    - Ability to act on objects
    - Ability to catch samples
  - Organisms
    - Distribution map
    - Still icon when caught with information
  - Classification
    - Game elements
    - Hint system
- Optional Features
    - Animated organisms in expedition sites
  - Purchasable items
    - Vehicle selection
    - Shop
  - Benson, EduVenturerers
  - Encounters with environmental issues at sites
  - Email/sms from scientists
  - Other museum acitivities

WebExpedition

-Map : MovieClip
-instance : ExpedSite
-taxonTop : Taxon
-taxons : Array
-taxNames : Array
-m_cnames : Array
-mainSprite : Sprite
-displayPanelSprite : Sprite
-loginFormat
-messageFormat
-taxons : Array
-tutSprite
-hudSprite
-hud
-currentTutorial
-currentWBench
-currentExSite
-currentLoc : String
-lastLoc : String
-collectionXML
-library
-messageField

+mapClicked()
+xmlImport()
+xmlLoaded(in event : Event)
+loadXML(in t : Taxon, in level : int)
+sortDispList()
+showVeil()
+hideVeil()
+clearMainSprite()
+clearTutSprite()
+createButton(in bLabel : String, in s : Sprite, in w : Number, in x : Number, in y : Number)
+createSprite()
+createText()
+WebExpedition()
+loadLibrary()

IntroTutorial

LabTutorial

BenchTutorial

-sDemo : MovieClip

+simulateScroll(in e : Event)
+empty()

HUD

-logoutButton
-returnButton
-dPanel

+HUD()
+pressedLogoutButton()
+pressedReturnButton()
+showHud()
+showScore()

Login

+Login()
+pressedLoginButton(in event : Event)
+logIn()
+newAccount()
+pressedRegAccountButton()
+pressedCreateAccountButton()
+pressedReturnButton()
+showLogin()

Tutorial

-tauno
-characterX1 : int
-characterY1 : int
-characterX2 : int
-characterY2 : int
-speechBox
-steps : Array
-step : Function
-clickDemo : MovieClip
-aKeys : MovieClip

+Tutorial()
+showTutorial()
+dismissTutorial()
+disableButtons()
+enableButtons()
+showCharacter(in n : int = 1)
+hideCharacter()
+showSpeechBox()
+hideSpeechBox()
+nextStep(in e : Event)
+prevStep(in e : Event)
+skipTut(in e : Event)
+completeTutorial(in e : Event = null)

NamingTutorial

-nGame : NamingGame
-pArrow : MovieClip

MapTutorial

ExpTutorial

-pArrow : MovieClip
-testOrg : Feature

+simulateLook(in e : Event)
+lookComplete(in e : Event)
+showArrow(in x : Number, in y : Number)
+handleArrow(in e : Event)

EduVenturesLab

-expeditionButton : MovieClip
-expedMessage : TextField
-workbenchButton : MovieClip
-labStuff : MovieClip
-floor : MovieClip

+EduVenturesLab()
+overExpeditionButton(in event : MouseEvent)
+outExpeditionButton(in event : MouseEvent)
+pressedExpeditionButton(in event : MouseEvent)
+pressedWorkbenchButton(in event : MouseEvent)
+overWorkbenchButton(in event : MouseEvent)
+outWorkbenchButton(in event : MouseEvent)

Workbench

-table : Sprite
-tableX : int
-tableY : int
-lZone : MovieClip
-rZone : MovieClip
-lDown : Boolean
-rDown : Boolean

+Workbench()
+showSpecimens()
+removeScrollListeners()
+addScrollListeners()
+frameAdvance()
+moveRight()
+moveLeft()
+stopMove()

-End3   -End4

1   *

Specimen

-Name : String
-area : Sprite
-container : MovieClip
-visual : MovieClip
-specimenTag : TextField
-texonLevel : int
-attempts : int

+Specimen(in cName : String, in tLevel : int, in attempts : int, in s : Sprite, in c : MovieClip, in x : Number, in y : Number)
+pressedSpecimen()
+overSpecimen()
+outSpecimen()

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Feature

-psi : Number = PI/4.3
-hc : Number = 60
-frameHeight/Width : Number = 400/747
-fieldRadius : Number = 800
-minRad : Number = 200
-nName : String
-h : Number
-xPos : Number
-yPos : Number
-ex : ExpedSite
-wi : Number
-hs : Number
-isPaused : Boolean

+setEx(in ex : ExpedSite)
+setNName(in n : String)
+pauseF()
+unPauseF()
+setX/YPos(in x/yPos : Number)
+Feature(in h : Number, in xPos : Number, in yPos : Number, in ex : ExpedSite) : <unspecified>
+setH(in h : Number)
+shuffle()
+displayable() : Boolean
+frameAd(in t : Number)
+getd() : Number
+getD() : Number
+act(in t : Number)

ExpedSite

-turnSpeed : Number
-lastTime : int = getTimer()
-features : Array = new Array ;
-theta : Number
-lDown : Boolean
-rDown : Boolean = false
-displist : Array = false
-keysOn : Boolean
-look : Number
-east : MovieClip
-west : MovieClip
-sun : MovieClip
-t : TimerBar

+getTheta() : Number
+setTheta(in t : Number)
+timeOut(in e : Event)
+ExpedSite(in type : String)
+keyDown(in Parameter1 : KeyboardEvent)
+keyUp(in Parameter1 : KeyboardEvent)
+rightKeyDown()
+rightKeyUp()
+leftKeyDown()
+LeftKeyUp()
+pauseSite()
+unPauseSite()
+hideFeatures()
+showFeatures()
+disableKeyListeners()
+enableKeyListeners()
+frameAdd(in event : Event)
+addF(in f : Feature)
+remF(in feature : Feature)
+shuffle()

*

1

-End2

-End1

PercentBar

-h : Number
-completeAt100 : Boolean
-selfUpdate : Boolean

+selfUpdateOn()
+setPercent(in p : Number)
+frameAd()

LoadingBar

-lBytes : Number
-tBytes : Number

+LoadingBar()
+frameAd()

TimerBar

-t : Number
-tf : Number

+TimerBar(in t : Number = 10)
+begin()
+frameAd()

Rock

-minRad : int
-maxRad : int
-minPoints : int
-maxPoints : int
-tehatVar : int
-radVar : int
-colors0 : Array
-alphas0 : Array
-ratios0 : Array
-colorVar : Array

+Rock()

Plant

+Plant(in h : Number = 50, in xPos : Number = -1, in yPos : Number = -1)
+clicked(in event : MouseEvent)

Animal

-speed : Number
-xLast : Number
-yLast : Number
-dir : int
-numDir : int

+Animal(in h : <unspecified> = 50, in xPos : <unspecified> = -1, in yPos : <unspecified> = -1)
+setSpeed(in speed : Number)
+animCheck(in e : Event)
+act(in t : Number)
+clicked(in event : MouseEvent)

AvatarMonitor

-instance : AvatarMonitor
-account : SharedObject
-t : Number
-n : Number
-qn : Number

+AvatarMonitor()
+setup()
+reset()
+attempt(in i : int)
+question(in taxon : String)
+toString() : String

1

*

-End15

-End16

Account

-currentAccount : Array

+Account(in u : String, in p : String, in s : int, in c : Array)
+passIsValid(in pass : String) : Boolean
+getAccount(in user : String) : Boolean
+getCollection() : Array
+passesMatch() : Boolean
+createAccount(in userName : String, in pass : String) : Boolean
+saveAccount()
+modSpecimen(in cName : String, in tLevel : int, in att : int)
+addSpecimen(in cName : String, in tLevel : int, in att : int)
+raiseScore(in a : int)
+getScore() : int
+visited(in loc : String) : Boolean
+setAsVisited(in loc : String, in visited : Boolean)
+getSpecimen(in cName : String)

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SpeciesEnterer

+TAXONS : Array
-w : MovieClip = new UpdatingWindow;
-types : DataProvider = new DataProvider
-editFields : Array = newArray
-specFields : Array
-editFieldsA : Array
-editFieldsD : Array
-specFieldsD : Array
-specFieldsA : Array
-initialized : Boolean
-newMode : Boolean
-changed : Array
-select : Taxon
-newtax : Array
-k : int
-newGaia : Gaia
-xml : XML
-gaia : Gaia
-taxons : Array
-taxNames : Array
-taxIds : Array
-m_cnames : Array
-xmlLoader : URLLoader

+getM_species() : Array
+getSpecies(in cName : String) : Species
+setup()
+messageUpdate(in e : String)
+clearMessage()
+ref(in e : Event = null)
+xmlImport(in e : Event = null, in f : Function = null)
+xmlLoaded(in event : Event)
+loadXML(in tax : Taxon, in lev : int)
+updateList(in e : Event = null)
+updateSelection(in e : Event = null)
+askWarning()
+deletea(in e : MouseEvent = null)
+delete2(in e : MouseEvent = null)
+cancel(in e : MouseEvent = null)
+newa(in e : MouseEvent = null)
+ok(in e : MouseEvent = null)
+export(in e : MouseEvent = null)
+export2(in e : Event = null)

Taxon

-name : String
-desc : String
-parent : Taxon
-children : Array

+Taxon(in orgXML : XML)
+getName() : String
+getParent() : Taxon
+getDesc() : String
+getChildren() : Array

Gaia

-version : String
-num : int

+Gaia()
+toXML() : XML

Species

-commonName : String
-displayType : int
-score : int
-high : Number
-med : Number
-low : Number
-height : Number

+Species(in orgXML : XML)

NamingGame

-format
-l : Number
-spec : Species
-lev : int
-choic : Array
-chosen : int = 0
-correct : Taxon
-img : MovieClip
-buttons : Array
-incorrect : int
-attemptsMade : int
-collected : Boolean

+NamingGame(in spec : Species, in incorrect : int, in exp : ExpedSite, in collected : Boolean, in lev : int)
+choose(in txn : Taxon)
+goBack(in e : MouseEvent)
+end(in levMod : int = 0, in atMod : int = 0)

ChoiceButton

-choic : Taxon
-n : NamingGame

+ChoiceButton(in i : Taxon, in n : NamingGame)
+qbClicked(in e : MouseEvent)
+clicked(in e : MouseEvent)
+setInactive()

Namibia

-HEIGHT : Number

+Namibia()
+makeMinimap(in org : String) : Namibia

FadingMessage

-del : Number
-fr : Number
-tl
-t

+FadingMessage(in e : String, in w : Number, in x : Number, in y : Number)
+update(in e : Event)

-End10
-End9   1
-End7   *
-End8
-End5   1
-End13   1
-End14   *
-End6   *

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APPENDIX K. FOCUS GROUP QUESTIONS FOLLOWING BETA-TESTING

Introductions and icebreakers

Before we talk about the game, we would like to discuss some of your current education.

1. How have you been taught about biodiversity in your school?

2. Do you think that you are being taught enough about the environment in classes?

3. What role do you think computers play in education? Compare this to how you are exposed to computers now.

Now let's talk about the game.

4. What did you like about the game?

5. What did you learn from the game?

6. What do you think might be improved?

7. Do you think that this game could be used in your schools to teach students about biodiversity? If yes, how could it be improved? If no, why not?

8. Would similar activities not on a computer be as useful?

APPENDIX L. EGAMEFLOW TEST

The EGameFlow test (Fu et al, 2009) is a series of Likert-style scale questions based on several categories. We have removed questions relating to online support related to the game as it should function as a standalone, as well as questions related to online communities. At the end of the test, the testees are presented with a visual analogue scale to rate their overall sense of enjoyment between 0 and 100. We have converted it from a seven point scale to a five point scale, as we feel seven choices are an overwhelming number.

		Disagree	-	-	-	Agree
C2	The game provides content that gets my attention	1	2	3	4	5
C3	Most of the gaming activities are related to the learning task	1	2	3	4	5
C4	No distraction from the task is highlighted	1	2	3	4	5
C5	Generally speaking, I can remain concentrated in the game	1	2	3	4	5
C6	I am not distracted from tasks that the player should concentrate on	1	2	3	4	5
C7	I am not burdened with tasks that seem unrelated	1	2	3	4	5
C8	Workload in the game is adequate	1	2	3	4	5
G1	Overall game goals were presented in the beginning of the game	1	2	3	4	5
G2	Overall game goals were presented clearly	1	2	3	4	5
G3	Intermediate goals were presented in the beginning of each scene	1	2	3	4	5
G4	Intermediate goals were presented clearly	1	2	3	4	5
G5	I understand the learning goals through the game	1	2	3	4	5
F1	I receive feedback on my progress in the game	1	2	3	4	5
F2	I receive immediate feedback on my actions	1	2	3	4	5

F3	I am notified of new tasks immediately	1	2	3	4	5
F4	I am notified of new events immediately	1	2	3	4	5
F5	I receive information on my success (or failure) of goals immediately	1	2	3	4	5
F6	I receive information on my status, such as score or level	1	2	3	4	5
H1	I enjoy the game without feeling bored or anxious	1	2	3	4	5
H2	The challenge is adequate, neither too difficult nor too easy	1	2	3	4	5
H3	The game provides "hints" in text that help me overcome the challenges	1	2	3	4	5
H5	The game provides video or audio auxiliaries that help me overcome the challenges	1	2	3	4	5
H6	My skill gradually improves through the course of overcoming the challenges	1	2	3	4	5
H7	I am encouraged by the improvement of my skills	1	2	3	4	5
H8	The difficulty of challenges increase as my skills improved.	1	2	3	4	5
H9	The game provides new challenges with an appropriate pacing	1	2	3	4	5
H10	The game provides different levels of challenges that tailor to different players	1	2	3	4	5
A1	I feel a sense of control the menu (such as start, stop, save, etc.)a	1	2	3	4	5
A2	I feel a sense of control over actions of roles or objects	1	2	3	4	5
A3	I feel a sense of control over interactions between roles or objects	1	2	3	4	5
A4	The game does not allow players to make errors to a degree that they cannot progress in the game	1	2	3	4	5

A5	The game supports my recovery from errors	1	2	3	4	5
A6	I feel that I can use strategies freely	1	2	3	4	5
A7	I feel a sense of control and impact over the game	1	2	3	4	5
A8	I know next step in the game	1	2	3	4	5
A9	I feel a sense of control over the game	1	2	3	4	5
I1	I forget about time passing while playing the game	1	2	3	4	5
I2	I become unaware of my surroundings while playing the game	1	2	3	4	5
I3	I temporarily forget worries about everyday life while playing the game	1	2	3	4	5
I4	I experience an altered sense of time	1	2	3	4	5
I5	I can become involved in the game	1	2	3	4	5
I6	I feel emotionally involved in the game	1	2	3	4	5
I7	I feel viscerally involved in the game	1	2	3	4	5
S1	I feel cooperative toward other classmates	1	2	3	4	5
S2	I strongly collaborate with other classmates	1	2	3	4	5
S3	The cooperation in the game is helpful to the learning	1	2	3	4	5
S4	The game supports social interaction between players	1	2	3	4	5
S5	The game supports communities within the game	1	2	3	4	5
K1	The game increases my knowledge	1	2	3	4	5
K2	I catch the basic ideas of the knowledge taught	1	2	3	4	5
K3	I try to apply the knowledge in the game	1	2	3	4	5
K4	The game motivates the player to integrate the knowledge taught	1	2	3	4	5

K5	I want to know more about the knowledge taught	1	2	3	4	5

Overall Sense of Enjoyment

APPENDIX M. NOTES FROM FOCUS GROUP WITH DELTA SCHOOL STUDENTS

Delta School Student Focus Group

04/01/2009

- Introductions
- Project description
- Questions

> **What are your favorite learning activities?**
>
> > Going to the lab
> >
> > Chemistry experiments (Example: viewing the breakdown of starch by saliva)
> >
> > Most students like practices: hands on work
> >
> > Occasional dissections of samples brought to the school
> >
> > Group work
> >
> > Science Fair
>
> **Do you play or have you played educational computer games?**
>
> > Grade 1-6: Jumpstart
> >
> > > It was fun
> > >
> > > Really enjoyed following the goals
> >
> > Grade 1-7 Math activities
> >
> > Typing of the Dead
> >
> > Magic Schoolbus
>
> **Do you have computers at home?**
>
> > All have computers at home
> >
> > One student plays a lot of games, others mostly for work except on weekends
>
> **Would you play an educational game about biodiversity?**
>
> > If the graphics amused me, it would have to look good
>
> **What is biodiversity? What does it mean to you?**
>
> > Different ecosystems interacting, the different kinds of organisms
> >
> > Hereditary relationships between organisms (i.e. different kinds of lizard are related)

How do you see environmental issues?

We have debates on environmental issues

Species are dying out, but people interfere too much

Pandas are poorly equipped to live in their own environment, and
should die out

Asian tiger to be moved to South Africa is a bad idea

Should be some protection of species

What environmental issues touch your daily life?

Namibia is very good environmentally

Biggest issues are droughts and UV light

The price of water goes up with droughts, but Namibia has one of the best
water recycling systems in Africa

Droughts in South Africa prevent produce growth

APPENDIX N. INTERVIEW QUESTIONS FOR NISE AND CLASH

Questions regarding students with language and hearing disabilities

1. What are the most important things to take into consideration when developing learning games for hearing impaired students?
2. How do hearing impaired students interact with computers differently?
3. What are some elements that we can include that will make the game more compatible with language and hearing impaired students?
4. What are some things we should avoid?
5. What do you see as the best format for getting input for *WebExpedition* from hearing impaired students?

APPENDIX O. NOTES FROM MEETING WITH CLASH

CLaSH Meeting

Tuesday, March 24, 2009

Participants: Heidi from CLaSH, Chris Jeznach, Phil Hardegen

- **Deaf vs. hearing impaired**
    o There is a difference between the deaf and the hearing impaired. This was important for us to note so we know what to say when we are communicating with the students. We needed to be sure that we were using the correct terminology.
- **Read and write**
    o Ability for deaf students to read and understand written language is difficult for them because sign language translates very differently from spoken sentences. This is why there is a lot of confusion when deaf students try to write. However, it is important to note that these students are not any less capable than students with good hearing.
    o Example: They [deaf students] need to grasp the whole concept of the subject. If they read the word "ecosystem," then they have to be able to create a sign for it, and when they have the sign, it sticks in their mind.
- **Visual aids**
    o Incorporating a lot of pictures into the game. The more visual the game can be, the better it will be for them.
    o Extremely important to incorporate into the game, if the visual aids can somehow be systematic, it will be even better.
- **Simple language**
    o Very simple language included in the game was essential for the deaf students to learn most effectively. We tried making the sentences as short and simple as possible.
- **Difficulties for deaf students to use a computer**
    o A problem for them might be, type in the following word, typing in the correct word might be difficult for them. At this point, we are not going to include much typing at all, moving the mouse and clicking would not be difficult for them.
- **Teaching deaf students**
    o Sometimes the deaf seem to be less intelligent or less able to understand concepts than other students. However, it is not the deaf, it is the inability of their teachers. If no one is able to explain it to them in a way that they could register it in their mind, than it is both the students and teachers inability.
- **Actually talking to the students about the game?**
    o 1st huge challenge would be to make them understand that this is a virtual game, however, if you would have a basic format or step 1, 2, and 3 on the computer they could see it. If they could see that, then they could understand it.
    o Sabino, a former participant in the EduVentures expeditions is a hearing impaired student who has helped us with talking to other hearing impaired or deaf students.
    o There are even some students who have worked in the lab at the museum, from the NISE.
    o "Would almost want to suggest talking to the students when the game is more developed, wait until you can actually make it a little bit more visual. We could see if Sabino understands the project. He could help us with getting the students

to come to the museum one afternoon, and just sit with the students to observe the game.

- o If we have a couple students and a teacher to actually assign to the students, it could help out a lot.
- o Might actually use Sabino to go to talk to the students who are interested, then the students themselves can decide which teacher they want to come along. They know who can sign well and who has the interest and motivation to help them.

APPENDIX P. FOCUS GROUP WITH TEACHERS

Focus Group with Six Secondary School Teachers

3-24-2009

Introductory Questions and input

- Will *WebExpedition* be an individual or group game?
- We should include information about San Culture and Archaeology
- Include Adaptation information
- One thing that maybe is missed on expeditions is the element of plants. The National Botanical Institute is an excellent resource.
- Another thing that is missing is the geological aspect. There are many incredible geological features in Namibia. The geological survey is a good resource for this.

Topics that most interest students:

Grade 7 science:

- There is so much about ecosystems that children do not know about. They go out to places in Namibia and don't know the names of the plants and the animals.
- Showing examples of actual specimens is very exciting.
- Namibians are naïve about their environment
- Common things and exciting things. Most exciting is common things that they will see themselves in day-to-day life
- Namibia has rich variety of different ecosystems
- Many Namibians are ignorant of house organisms. They are scared of things that they shouldn't be.
- Different stages of development for insects
- Water is something that everyone deals with. It is also a big part of Expeditions. Water management and water in ecosystems would be good to include. In the case of flooding, there is plenty of water, but how much is drinkable?

Are students interested in environmental issues?

- Students are interested in environmental events that are going on around them locally like flooding and changes in weather patterns.

- Ramatix Textiles was a large Malaysian textile factory that packed up and left, leaving much chemical dyes and other pollutants in the ground.
- The building of hydroelectric dams and Uranium mines are two other pertinent and current environmental issues
- There are often tradeoffs made between conserving biodiversity and energy production methods.
- Wind turbines being built, but their effect on the environment must be considered.
- Impact of Quad Bikes out in Swakopmund in the Desert
- People's effect on the environment
- Awareness of the environment

Where might these topics find a place in the curriculum?

- Life Science grade 10
- Biology Grade 12
- Grade 8 and 9 Geography; Population Movement
- Classification begins at grade 8 life science and goes up through grade 12

There is not really one place in the curriculum where environmental issues are taught. They fit into many places in the curriculum.

In General, how comfortable are teachers using computers?

- Most teachers are uncomfortable using computers.
- It really depends on the individual school and its resources. I come from a school with computer centers. Many schools don't have them.
- Computers are located in a computer center, not in individual classrooms.
- Computers are not very often used as part of a class. Computers are most often used as part of a specific computer studies class
- There is a wide range of expertise in computer usage for students and teachers. Some don't even know how to turn them on, and some are very familiar. It depends on where the students are from, and the resources of the schools.
- Most government teachers are not familiar with computers.
- Sometimes I can reserve time and take students into the computer lab for half an hour, maybe an hour
- In computer classes

Do you see this game fitting into the school day or would it be better for students to play on their own?

- It can be for either or both settings, depending on the individual school.

How do you see computer use in schools progressing in the next five years?

- Don't see a vast change in next five years. If there is a change, it will be slow
- Cell phone computer interaction is growing, even among poor kids.
- Kids are definitely becoming increasingly technology aware.
- There is a move towards projectors and interactive whiteboards in Delta School
- SchoolNet's computers are very old, often donated. The internet provided is not always reliable.

What specifically would you like to see in *WebExpedition*?

- I would like to see actual specimens
- Include Snakes. The Black Mamba; why is it called that?
- This game will be very useful as reinforcement for sign language. The visuals of the specimens will help to make the gap for deaf teaching.

What is the best time to hold a focus group with students? When do they leave school?

- Most schools finish around 1:00
- Sports practices are usually later in the afternoon from 3 to 5

What is a good incentive for getting students to attend?

- The event itself should be enough motivation to get them to attend.
- Refreshments are fine, but wouldn't be the main incentive.

APPENDIX Q. INDIVIDUAL TEACHER MEETINGS

Meeting with Karin

Teacher of science

Delta School in Windhoek

03/31/2009

- Karin has talked to several students about the *WebExpedition* and four students are interested in getting involved with the game and helping out with the beta tests.

- The computer labs at the school are available for use

- We have determined that none of the classrooms have computers in them so during actual class periods students do not use computers. The only way they would use computers during class period would be if they went to the computer lab.

- The only computer use that Karin could think of was that the principal used Encarta to show movie clips and what not, there was activity taking place where the principal would hold a large meeting and educate the students on specific matters.

- It is not that easy for the other subjects to use the computer classroom because of availability issues. The computer classes use the computers during most of the day and it is extremely tough to schedule a time for the computer lab.

- Since Delta is a fairly privileged school, we should not base all of our results just strictly on this school. It is nice to see that this school has ample computer access but it is certainly not representative of other schools in Windhoek.

- We will be holding a focus group with some of the students to ask them questions about what they think of the game and what content should be included.

Meeting with Alison

Teacher for grade 8 & 9 science

St. Paul's College

04/06/2009

- How large is the school? – 480 students
- What grades? – 8-12
- Located on Sam Nujoma Street
- Private versus government? – Private
- More privileged than other schools
- Computer labs? – only one computer lab in the school
- Science labs? – all grades include a lab, chemistry and biology lab, classification is a short part of grade 10,

- Computers are used in the classrooms as PowerPoint presentations but that is really it.
- Computers are available after school as well but it seems as if students are not using this to their advantage.
- Most important subjects to learn about – Geography would also be important, sustainability is not really included at all in grade 11, the only thing in grade 10 is the dichotomy. Geography could be another aspect added to the game where students go ahead and learn about the various issues associated with a specific region in Namibia.
- A few students would work on the project privately, but is something that St. Paul's teachers can use in the classroom. One classroom just did two projects on indigenous plants with the students.
- St. Paul's teachers think that the project would be better if it was geared towards grade 8 ad 9 students and not necessarily just secondary school students.
- Since St. Paul's is so pressed for time, it is very difficult to include new material into the current curriculum. However, towards the end there is a little bit of ecology in grade 12.
- Include rural development, in the north it has become a land of desert, the people of the North are moving around and ruining some of the land in the North. These people should be given a set amount of land that they have to cultivate and take care of; otherwise all of the land in the north is going to become unusable.

Meeting with Bruce

Teacher of science

Combretium School

- Private School
- 25 students per grade
- 125 total students in school
- Targeted for families making lower income
- No computer lab, but do have laptops
- Students can go to the American Cultural Center to use their computers

Classroom observation of Bruce teaching:

Lab period

Grade 10

Physical Science

- No computers in the classroom or in the school that means that it would very difficult for the students to use *WebExpedition* in the school. However, very few laptops are available for students to use so this could be a possibility.
- Students quickly join groups of 3-4 to work on a lab project. Goes to show that group work places an important role in the science curriculum.
- Students immediately start an experiment to measure the thermal conductivity of various materials.
- It is stated from the very beginning by the teacher that each student is going to hold a responsibility. This is nice to hear because this is what EduVentures expeditions are all about. Students working together but each student is actively contributing to the end goal.
- There is not enough supplies for every group, so groups have to share and even use makeshift supplies.
- Lab essentially consists of small school desks, clamp for thermometer. This could be an indicator that this school is relatively underfunded and could use more resources for students to learn.
- Some students are working well together and some are sort of just sitting around.
- Teacher brings in outside examples and gets students to relate the experiment in a creative way. He discusses the definition of a "control," by using fertilizers as an example and says that if you have two fertilizers and are trying to see which one works better, there is no way of telling by just comparing the two fertilizers against each other. A control has to be introduced in order to determine which fertilizer works better. He then explained that in order to measure the thermal conductivity of two materials, a control has to be introduced to compare the materials to each other.
- Another real life example to the altitude of Windhoek and why the water boils at a lower temperature than in other places in Namibia. It is because of the high altitude. The students found this very interesting and were very curious.

Interview with Bruce:

- Combretium school tries to target families with lower income but those who do not want to send their kids to government schools.

Computer Access

- The students at the school have a wide range of computer skills. Some of the students can do just about anything on the computer while other students still do not know how to turn a computer on. There is a wide range of students at Combretium School.
- Combretium School does not have a computer lab, so computers clearly are not integrated into the current curricula. However, students do have the opportunity to go to the American Cultural Center and use their computers. Combretium has some sort of a partnership with the ACC whereas students can go to the center on Wednesdays and use the computers for free.

Game Content

- Students want to see interesting and fascinating material. If the content in the game is not interesting or appealing to them, they are not going to play the game. Material should be added to the game that attracts the students, such as someone holding a real live scorpion, etc.
- As aspect of the game that would also attract students would be something similar to the popular television show "MythBusters." We could somehow integrate this into the game and include material such as "are spiders in Namibia really dangerous, or is this just a myth." And information about solifuges because there is a lot of false information spreading about these insects.

APPENDIX R. INTERVIEWS WITH STUDENTS WHO HAVE BEEN ON AN EDUVENTURES EXPEDITION

Student 1

1st year student at Polytechnic of Namibia

Attended St. Paul's College

04/08/2009

1. **What were your overall thoughts on the expedition that you went on? Was it interesting?**

   - Firstly, they combined it with hearing-impaired students from NISE, the most that I got out of it was an understanding of kids with disabilities. Secondly, was the actual expedition, collecting insects, and going to parts of Namibia that not that many people have been to.

   - We all were one group, every single day we would wake up really early, spots marked on the map and decide that we are going to check here, and collected everything that we saw.

2. **Which expedition did you go on?**
   - 7th Expedition, Gondwana Canon Park
   - 50 students

3. **Did the expedition increase your interest in biodiversity at all?**
   - It was just fun and interesting. Dad is a nature conservationist. Got over a fear of insects and arachnids. Now that he knows more about the different creatures, he is not as scared of them.

4. **Why did you go on the expedition?**
   - EduVentures came to St. Paul's and announced it during an assembly, there were only 4 students who showed interest. All 4 students ended up going. Mrs. Gardiner was the main person who helped. Field trip was during school.

5. **Do you think it is important that EduVentures takes students on expeditions in the future?**
   - It makes people less ignorant to the world around them, especially learning to work with deaf students, tolerance. We worked individually but all in mind of the team and the bigger goal.

6. **Are there other students at your school who you think would have liked to go on an expedition with EduVentures?**

- St. Paul's students are used to their luxuries, they are not used to getting out of their comfort zone.

7. **Do you think that students would be interested in playing a game like *WebExpedition*?**
   - Yeah, everyone loves playing games.

Student 2

12th grade student

DHPS

1. **What were your overall thoughts on the expedition that you went on? Was it interesting?**
   - Went on 10th project expedition, and Baynes Mountains expedition.
   - Expected to make a larger discovery on the Archaeological expedition
   - "I think we could have been more successful by talking to the local people about their knowledge of potential archaeological sites."

2. **Did the expedition increase your interest in biodiversity at all?**

   - Yes. Out there I felt very close to nature. We were a part of nature when we were out there. The beginning was fun and the end was fun. The trip was very challenging, but looking back I am glad I did it. It was a very adventurous experience. On the archaeological trip we found an abandoned hut and made conclusions about the people that had been there. The Archeologist had interesting information to say about it.

3. **Do you think it is important that EduVentures takes students on expeditions in the future?**

   - Yes, more kids should participate in events like this.

4. **Are there other students at your school who you think would have liked to go on an expedition with EduVentures?**

   - Yes. There are students who regret not volunteering when they had the chance. More students would definitely like to, although not everyone knows about the opportunity.

5. **Do you think students would be interested in playing a game like *WebExpedition*?**

   - Yes. I think having it on the website is a good idea, and that students would definitely want to play. EduVentures should advertise more, because not every student knows about it. Also, not a lot of people know about the national museum research facility. They know about the exhibits, but nothing about the research.

APPENDIX S. CLASSROOM OBSERVATION WITH NISE TEACHER

Classroom Observation

NISE

Secondary School

Physical Science Lesson

Grade 10

Material Being Taught:

Classifying

- Hard or soft
- Metals or non-metals
- Solid, liquid, gas
- Elements, compounds, mixtures
- Natural or synthetic
- Describes how to make coffee in order to explain mixtures
- Types of mixtures
    - A mixture that consist of two solids
    - Sand + Iron (fillings)
    - Solid + liquid (coffee and water)
    - Liquid and liquid (oil + water)
    - Liquid and gas
- Methods of separation
    - Hand sorting
    - Using a magnet
    - Using a separating funnel

Observations of Classroom

- The teacher is given a lesson plan, which is essentially a packet of paper that he has to teacher the given lesson
- Classroom size is 7 students (6 female, 1 male)
- All students are wearing uniforms
- Male is not very involved in the discussions and females seem to ask more questions
- Classroom is very personal and close-knit
- Teacher is very good in the sense that he seems to really connect with the students and know exactly how to teach the material
- There are posters on the walls describing the geography, science, pH scale, classification of arachnids (order, class, phylum)
- Teacher brings in outside examples to help the students learn
- Students help each other with learning if they do not understand something
- Creating the computer game so that the students can work with each other would be good
- Most students ask questions and seem very happy with learning

- Tomorrow they are going to visit the school with the big lab and the students will see magnets for themselves
- Teacher tries to get students involved who are not participating as much, asks them if they have anything that they want to add

Questions for students:

What interests you most in science?

- Student 1: no interest in science, he likes to draw the elements structure
- Student 2: pushing and the pulling of the force and how to figure out the calculations
- Likes very much about that, a lot of studies about Namibian animals,
- Student 3: What interests her most is the way that people use symbols
- Student 4: Like science because it is very interesting, likes solving problems with science like e=mc2, likes experimenting with the environments,
- Student 5:
- Student 6: Need to know how to take care of the animals and the environment in order to protect them
- Student 7: Likes to learn more about the apes and baboons, likes more about the human body and how we can take care of it

Interview with EduVentures participants:

What did you enjoy most when you went on your trip with EduVentures?

Student: Working on the spider project, it was quite an experience for her because she learned a lot about how to learn about the different organisms, it can hurt the animals if you don't treat them correctly, going out deep into the wilderness was interesting, important that she learned that the spiders were a bit different in various parts of Namibia.

Student: Same ideas as the other person, learned that some scorpions are venomous and need to be careful when working with them, learning about snakes, be careful because they can spit venom into your face.

-Exams are given that describe how to classify different organisms, so incorporating this into the game will be essential.

Computer Lab

-Consisted of two computers in a very small room. One of the computers was broken. The computers were provided by SchoolNet Namibia.

APPENDIX T. OWNER'S MANUAL

ADDING ORGANISMS

WebExpedition allows the addition of organisms without a single line of code. To demonstrate how to do this, we will be adding a *Homo sapiens*, or human. These instructions assume basic knowledge of creating MovieClips in Adobe Flash. Before you enter an organism you will have to have the following:

- The common name of the organism, using underscores instead of spaces
- The taxonomic name of the organism, as follows:
    - o Kingdom
    - o Phylum
    - o Class
    - o Order
    - o Family
    - o Genus
    - o Species
- A brief description of the organism
- A map of the relative population density of the organism in Namibia

ADDING THE ART

The first thing that will have to be created for the organism will be the art for the organism. There will be two movie clips for the organism: a high detail MovieClip for the organism description, and a low detail MovieClip for appearing in Expedition Sites.

For the description image, create a new MovieClip in the *WebExpedition*.fla file called *commonName_*d For example, we will create a movie clip named Human_d. Export it for ActionScript. Draw your image. Once the image is drawn, select the entire image and move it to (0,0). Add this movie clip to the Organism_Art→Details folder.

For the live art, create a new movie clip called *commonName_*li. Export it for ActionSpript, and have it extend the class of the controller you would like to use for its movement. The possibilities are as follows:

- Animal – the organism will move at its set speed away from the center of the view
- Plant – the organism will stay still

You can then create the live art for the organism. If it is an animal, the art can cover at least one and any higher number of directions for movement. The directions are numbered from 0 up from forward. To create an animation or image for the directions, give them frame labels dir*N*, where *N* is the number of the direction.

In Scene_1 on the Organisms layer in frame "Art" add an instance of each of the organism arts. Label the live *commonName*_live and the detail *commonName*_detail. In our case, Human_live and Human_detail.

ADDING DISTRIBUTION INFORMATION

To add the information about distribution to the game, open the Namibia MovieClip from the Library. Hide the "Visible" and "Pop" folders. Create a new layer called *commonName* (i. e. in our example, Human). With Merge Drawing on, draw the low, medium, and high areas of density with three non-stroked shapes: blue for low, green for medium and red for high.
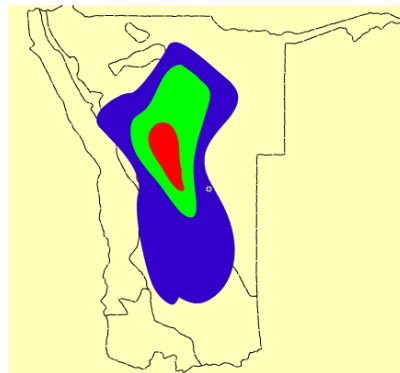
Select the blue area, and convert it into a movie clip named *commonName*_low. In our case, Human_low. Name the instance of the movie clip the same. Repeat for the medium and high, naming them *commonName*_med and *commonName*_high respectively. Once that is complete, add the layer to the Pop folder.

ADDING OTHER STATISTICS

The rest of the information about an organism, and indeed what includes the organism, is within the XML file XMLSkeleton.xml. To add an organism to the XML, go to http://www.eduventures-africa.org/SpeciesEnterer.htm. This tool will modify the xml file at http://www.eduventures-africa.org/7_*WebExpedition*/XMLSkeleton.xml. Here, you can press the new button to create a new species, or edit old ones. Pressing ok will apply the changes, or will prompt you for more information. Updating the XML can take longer than five minutes if the server is slow.
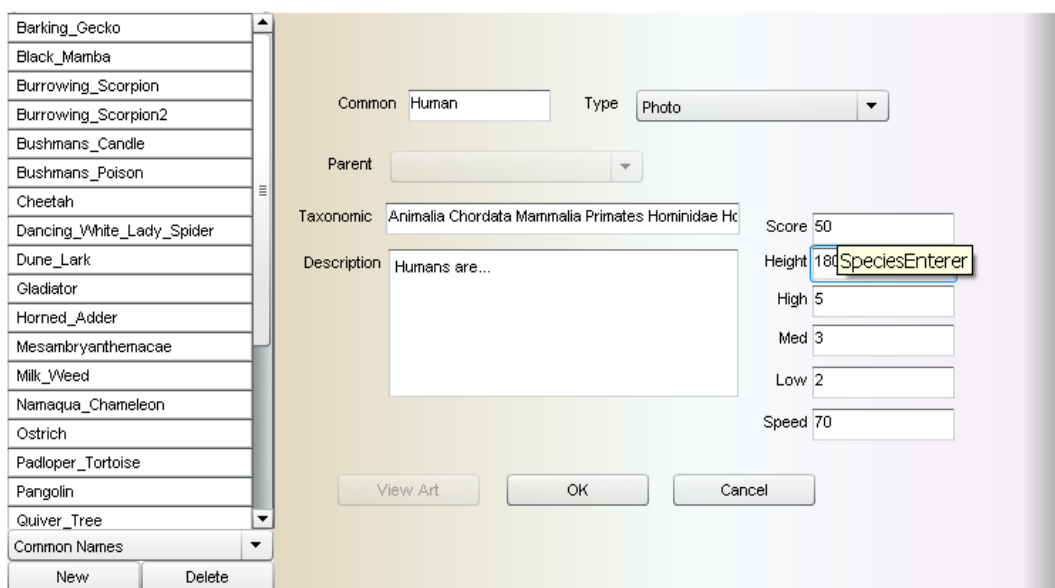
Field Name	Description
Type	The way in which the organism appears in the collection
Common	The common name of the species
Taxonomic	When creating an organism, the entire taxonomic name with each name separated by a space. When editing a taxon, it is the name of that taxonomic level
Description	A description of that taxonomic level
Score	The maximum number of points a user can get for catching and naming one of the organism
Height	The height of the organism when appearing on screen. (Lowest height should be 60 in order for the organism to be visible on screen)
High, Med, Low	The maximum number of a species you'll find in the high, medium, and low density zones.
Speed	The speed at which the organism moves

APPENDIX U. SUGGESTIONS FOR USE IN CLASSROOM

EduVentures *WebExpedition*

Suggestions for using *WebExpedition* in the classroom

Purpose:

This purpose of these suggestions is to offer ideas on how *WebExpedition* can be used as part of classroom learning. It is meant to help correlate the material presented in the *WebExpedition* with that material that students are learning in the actual classroom.

WebExpedition can be used as an introduction to these topics, and alternatively as a reinforcement tool. Students can play *WebExpedition* as a fun way to get acquainted with topics before doing further classroom work with the topics. It can also be played to further reinforce students' ability to classify organisms and to connect organisms with where they are found in Namibia.

Suggestions for Ways to Introduce *WebExpedition* to Students

I. **Biomes -** *WebExpedition* can be introduced to the students by explaining what Namibia's various biomes are and describing what characterizes each biomes. Other suggestions include why biomes are classified, what the pressures are on Namibia's biomes, and what can be done to reduce the pressures. The biomes presented in *WebExpedition* are:
   i. Desert
   ii. Nama-Karoo
   iii. Savanna
   iv. Succulent Karoo

II. **Classification of Plants and Animals** – *WebExpedition* can be introduced to the students by going over the various taxonomic classifications for animals and plants. Since classification is already a part of the biology curriculum provided by the Ministry of Education, this aspect of *WebExpedition* can be used to teach the students.

III. **Environmental Issues** -- Since *WebExpedition* includes Namibia's biomes and various plants and animals; it can be introduced to students by explaining Namibia's environmental issues and how they affect the various biomes. Some of the environmental issues introduced to the students may include:
   a. Desertification
   b. Bush encroachment
   c. Sustainable water use
   d. Balancing the cost of wildlife
   e. Mining and the environment
   f. Lack of recycling

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APPENDIX V. REFERENCES FOR PICTURES IN *WEBEXPEDITION*

Since we used some of the ideas of actual pictures to create the computer images in *WebExpedition*, the sources for the pictures are listed here according to the animal or plant and the biome that it is found in:

ANIMALS				
Desert	**Source**	**Savanna**	**Source**	
Dancing white lady spider	DRFN	Black mamba	EduVentures	
Dune lark	DRFN	Pangolin	EduVentures	
Horned adder	EduVentures	Gladiator	EduVentures	
Solifuge	EduVentures	Ostrich	EduVentures	
Opistophthalmus flavescens	EduVentures	Termite's	EduVentures	
Nama Karoo		**Succulent Karoo**		
Large huntsman spider	EduVentures	Barking gecko	EduVentures	
Monkey beetle	EduVentures	Opistothalmus harpei	EduVentures	
Namaqua chameleon	EduVentures	Cheetah	EduVentures	
Parabuthus schlechteri	EduVentures	Springbok	EduVentures	
Padloper tortoise	EduVentures	Large huntsman spider	EduVentures	

PLANTS			
Desert	**Source**	**Savanna**	**Source**
Milk weed	EduVentures	Bushman poison	EduVentures
Tall bushman grass	EduVentures	Tamboti tree	Mannheimer 2005
Welwitschia	EduVentures	Vermeerbos	Mannheimer 2008
Wild everlasting	EduVentures	Silky bushman grass	EduVentures
Wild green hair tree	DRFN	Camelthorn	DRFN
Nama Karoo		**Succulent Karoo**	
Quiver tree	EduVentures	Namib lily	EduVentures
Halfmens	Mannheimer	Pig's ear	EduVentures
Mesembryanthemacae	EduVentures	Quiver tree	EduVentures
Bushman's candle	EduVentures	Halfmens	Mannheimer
Lithops karasmontana	EduVentures	M. hypertrophicum	EduVentures

# APPENDIX W. REFERENCES FOR INFORMATION IN *WEBEXPEDITION*

These are the sources used for the information for the plant and animal species in *WebExpedition*:

ANIMALS			
Desert	**Source**	**Savanna**	**Source**
Dancing white lady spider	DRFN	Black mamba	Branch 1998
Dune lark	DRFN	Pangolin	Cille 1987
Horned adder	Branch 1998	Gladiator	EduVentures
Solifuge	EduVentures	Ostrich	DRFN
Opistophthalmus flavescens	EduVentures	Termite	Uys 2002
Nama Karoo		**Succulent Karoo**	
Large huntsman spider	EduVentures	Barking gecko	EduVentures
Monkey beetle	EduVentures	Opistothalmus harpei	EduVentures
Namaqua chameleon	EduVentures	Cheetah	Cille 1987
Parabuthus schlechteri	EduVentures	Springbok	Cille 1987
Padloper tortoise	EduVentures	Large huntsman spider	EduVentures

PLANTS			
Desert	**Source**	**Savanna**	**Source**
Milk weed	DRFN	Bushman poison	EduVentures
Tall bushman grass	DRFN	Tamboti tree	Mannheimer 2005
Welwitschia	EduVentures	Vermeerbos	Mannheimer 2008
Wild everlasting	EduVentures	Silky bushman grass	EduVentures
Wild green hair tree	DRFN	Camelthorn	DRFN
Nama Karoo		**Succulent Karoo**	
Quiver tree	EduVentures	Namib lily	EduVentures
Halfmens	Mannheimer 2008	Pig's ear	EduVentures
Mesembryanthemacae	EduVentures	Quiver tree	EduVentures
Bushman's candle	EduVentures	Halfmens	Mannheimer
Lithops karasmontana	EduVentures	M. hypertrophicum	EduVentures

E-game Flow Results: Concentration
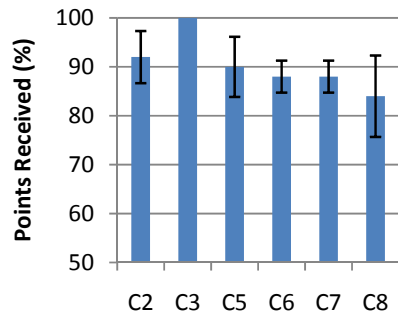
C2 – The game grabs my attention

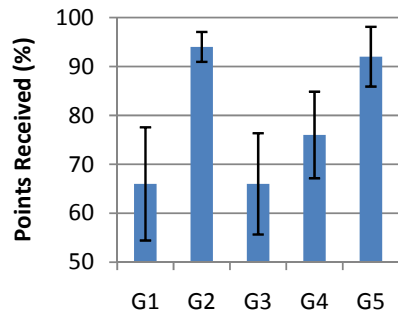C3- Most of activities in the game are related to the learning task

C5 – I can remain concentrated in the game

C6 – I am not distracted from tasks that I should concentrate on

C7 – The tasks in the game fit with its overall goal

C8 – Workload in the game is adequet

E-game Flow Results: Goal Clarity

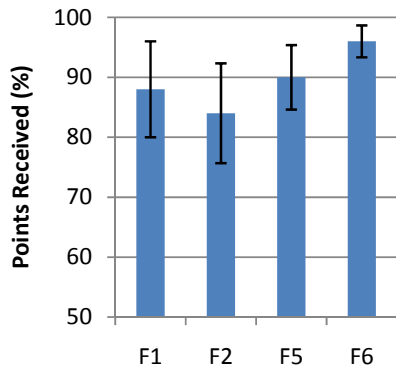G1 – Overall game goals were presented at the beginning of the game

G2 – Overall game goals were presented clearly

G3- Intermediate goals were presented at the beginning of each scene

G4 – Intermediate goals were presented clearly

G5 – I understand the learning goals through the game

E-game Flow Results: Feedback


F1 – I receive feedback on my progress in the game

F2 – I receive immediate feedback on my actions

F5 – I receive information on my success (or failure) of goals immediately

F6 – I receive information on my status, such as score or level

E-game Flow Results: Challange
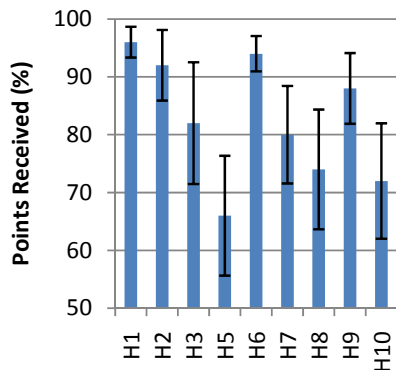
H1 – I enjoy the game and do not feel bored or anxious

H2 – The challenge is neither too difficult nor too easy

H3 – The game provides "hints" in text that help me overcome the challenge

H5 – The game provides video or audio auxiliaries that help me overcome the challenges

H6 – My skill gradually improves through the course of overcoming challenges

H7 – I am encouraged by the improvement of my skills

H8 – The difficulty of challenges increased as my skills improved

H9 – The game provides new challenges with an appropriate pacing

H10 – The game provides different levels of challenges that tailor to different players

E-game Flow Results: Autonomy
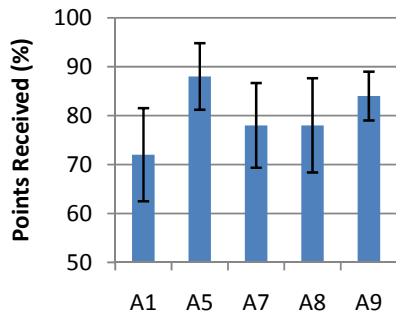
A1 – I feel a sense of control of the menu

A5 – The game supports my recovery from errors

A7 – I feel a sense of control and impact over the game

A8 – I know the next step in the game

A9 – I feel a sense of control over the game

E-game Flow Results: Knowledge Improvement
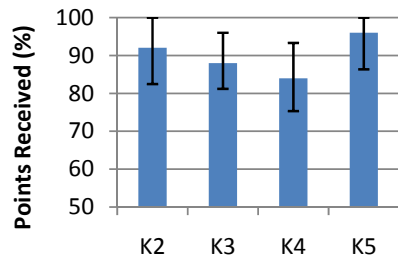
K2 – I catch the basic ideas of the knowledge taught

K3 – I try to apply the knowledge in the game

K4 – The game motivates me to use the knowledge taught

K5 – I wasn't to know more about the knowledge taught