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An Evaluation of Language Ontology Web Based Assessment System

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Article Info	ABSTRACT
	The field of e-learning has improved tremendously in the past decade with the invention of all kinds of e-leaning systems contributing to the quality of education. The undertaken research seek to improve web assessment systems which are limited to multiple choice type of assessment which is summative assessment that does not have a feedback section to students hence promote limited learning. The proposed system uses ontologies to promote formative assessment with a feedback loop to the students. The structured type of questions are now implemented in web assessment systems instead of using multiple choice type of questions which have limitations in terms of functionality when it comes to marking textual answers due to wide variety of words that can mean the same thing. The designed system was implemented using an ontology based dictionary which generates all possible solution for a particular question and uses aspects of artificial intelligence. The system was applied to two primary schools students doing grade 4 levels. Students wrote a test that was marked by both the system and teacher. Results from the study showed that the system marks as close to the human examiner and is the ideal assessment and marking if implemented well.

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1. INTRODUCTION

The field of e-learning has advanced tremendously but it seems few have embraced it. Though there have been some aspects of e-learning which have been extensively used such as e-books, the authors feels this technology (e-learning) if implemented correctly in the right environment and with adequate resources can infiltrate or be used in many areas such as education, private and public institutions used by people of all works of life. Not to say such systems do not exist, the authors propose an assessment system that is flexible and with enough functionality to be implemented in different environments as those described above. Since the advancement of such a system is to replace the examiner in the area of assessment, the system basically has to employ aspects of artificial intelligence for it to be useful. Incorporating ontologies in such systems would give them the advantage of a wider and intelligent knowledge base.

1.1 Background of study

Distance education has helped to overcome various obstacles faced in imparting education to students who cannot make it to education centers for one reason or the other. It conquers the problems of logistics, transportation, infrastructure, time etc. that are commonly faced by educational organizations and students. With the spread of internet growing across the globe it is becoming more and more accessible to all

the corners of the world which also means that students now have access to better education using the Internet. Lessons, lectures, notes, assignments, exams etc are now available online using Internet and students can access them from anywhere. Given the emergence of online learning as a new form of education, a number of studies have been devoted to it. However assessment, which is an important, well established and popular slice of the e-learning universe, has not attracted the attention it deserves [1]. According to reference [2], future research studies should be designed to explore more innovative, efficient, and effective instructional and assessment techniques for the online environment. Current learning approaches to assessment commonly demand the multiple choice type of questions which encourage guessing and does not effectively assess students. Hence there is need to automate assessment of exams and to employ artificial intelligence so that we preserve human aptitudes since the human examiner scenario is considered the best.

On the other hand, development of ontology based systems has been a topic of interest for computing scientists since the early 1990s. Over the years a number of different ontology formalisms, methodologies and their supporting tools have emerged to help the subject specialists to build ontologies. However, when attempting to create ontology of wide ranging subjects and history, a number of specific challenges related to the nature of the domain arise. These include time dependence, subjectivity and uncertainty.

The authors introduced this phenomenon of ontologies to online examination systems as a way of imitating human examiners and to bring confidence in the use of such systems whilst reducing examination personnel with an overall goal of promoting distance learning. The paper is arranged as follows: the problem statement and research questions follow the introduction and background study. This is then followed by the literature review section and the methodology section. The results and analysis follows with the discussion and conclusion rounding up the research with acknowledgements.

1.2 Problem statement

The evaluation of the students' knowledge or skills is a basic activity in both traditional education and E-learning. Web assessment systems brings an interesting research area where the main objective is giving the students the possibility of being evaluated more frequently so that they would receive feedback about their strengths and weaknesses, thereby improving the evaluation process. However, it is not an attempt to giving more work to teachers or replacing human aptitudes such as evaluating personal opinions, creative or original answers; the teacher criterion is always the most important factor. Conventionally, the most comprehensive and common way of assessing students has been through open question formulation and answering. There is need to preserve that traditional approach but now replacing the same concept with online examination systems. The evaluation of open questions without human participation lags behind and is crucial issue given the need of evaluating natural language text; hence there is need for inclusion of artificial intelligent to match that of human examiners. The marking process should include lenience and careful judgment. The article seeks to design and implement ontology based web assessment system for primary school students that mark short textual answers and assess if the ontology web assessment system can mark as human examiners do. It further assess whether ontology web based assessment systems can be lenient as human examiners do and also be of beneficial to students.

1.3 Research Questions

The paper seeks to answer the following research questions:
1. Can ontology based web assessment systems mark as human examiners do?
2. Is ontology based web assessment system more accurate than human examiners?
3. Is the system lenient when marking as human examiners do?
4. Are the possible answers generated by the system ontology helpful to the students?

1.4 Research propositions / hypothesis and assumptions

We hypothesize that the available web assessment systems leg behind in marking short textual answers and complexity of different possible answers to a question remains a challenge hence incorporating ontology will reduce that complexity. We further hypothesize that if human leniency and careful judgement is imitated, web assessment systems can assess as human examiners do. The research shall uphold the assumptions that one can define classes, objects and the relation between classes in the same domain exhaustively and the ontology will be used over a long period of time probably up to thirty years.

2. LITERATURE REVIEW

2.1 Ontologies and Knowledge bases

The word ontology has got philosophical origins. As reference [3] referred in the philosophical sense, an ontology as a particular system of categories accounting for a certain vision of the world. As such, this system does not depend on a particular language: Aristotle's ontology is always the same, independently of the language used to describe it. On the other hand, in its most prevalent use in Artificial Intelligence, ontology refers to an engineering artefact, constituted by a specific vocabulary used to describe a certain reality, plus a set of explicit assumptions regarding the intended meaning of the vocabulary words [4]. Artificial Intelligence (AI) practitioners are currently using the word ontology to formally represent domains of knowledge [5]. Ontologies are a hierarchal description of the important concepts in a domain, coupled with a description of each of these concepts. Ontologies consist of various concepts that include: class, subclass, class hierarchy, instance, slot, value, defaults value, facet, type, cardinality, inheritance, variable and relation. In this regard, ontologies can be thought of as semantic primitives that specify a particular domain of knowledge. The main advantage for having such formal specification is to facilitate the knowledge sharing and re-use among the various parties interested in that particular domain of knowledge. As the result of the thorough analysis, some researchers suggested to weaken the popular— but often misunderstood and mis-cited—definition of "a specification of a conceptualization" by [6] to "a logical theory which gives an explicit, partial account of a conceptualization" [3].

Sometimes, ontologies are confused with knowledge bases, in particular because the same languages (OWL, RDF-S, WSML, etc.) and the same tools and infrastructure can be used both for creating ontologies and for creating knowledge bases. There is, however, a clear distinction: Ontologies are the vocabulary and the formal specification of the vocabulary only, which can be used for expressing a knowledge base. It should be stressed that one initial motivation for ontologies was achieving interoperability between multiple knowledge bases. So, in practice, an ontology may specify the concepts "man" and "woman" and express that both are mutually exclusive—but the individuals Peter, Paul, and Marry are normally not part of the ontology. Consequently, not every OWL file is ontology, since OWL files can also be used for representing a knowledge base.

The main difference between traditional knowledge bases and ontologies is that the former often tangle the dimension of search paths with the actual domains representation. In particular classical knowledge base systems mostly lack a clear notion of what it means to be an instance or a subclass of a category. For example, the directory structure on our personal computer is a KOS, but not an ontology— since we mostly put a file into exactly one single folder, we try to make our folder structure match our typical search paths, and not to inter subjective, context-independent, and abstract categories of things [7].

2.2 Web Assessment

Given the emergence of online learning as a new form of education, a number of studies have been devoted to it. However assessment, which is an important, well established and popular slice of the e-learning universe, has not attracted the attention it deserves [1]. Although educators at all levels have embraced using online technology as a teaching tool, the issue of assessment of student learning in an online course has not been thoroughly addressed [8]. A study conducted at the University Of North Dakota explored the methodology, benefits, and challenges of conducting student assessment in an online course. It compared student learning outcomes of an online course with student learning outcomes of a traditional course. Several questions were derived from this study that suggests educators need to do more quality assessment when they offer online courses [8]. Online assessment is a method of using computers to deliver and analyse tests or exams and such systems have been around since the seventies [9]. It is the process of identifying, collecting and interpreting information on students' achievement and progress. This implies that assessment may affect decisions about grades, placement, instructional needs, and curricula [1]. Although there are a lot of researches on e-learning, web assessment is lagging behind yet it is a crucial aspect of the learning process. According to reference [2], future research studies should be designed to explore more innovative, efficient, and effective instructional and assessment techniques for the online environment. Reference [10], outlined the five major uses for assessment reflected as: converse the success status for students, offer self-evaluation information to the learner, student assignment for educational paths or programmes, stimulate the learner and assess the efficiency of instructional programmes.

Assessment is mainly divided into two types that are formative assessment and summative assessment. According to [1], summative assessment is given to summarize the student's learning over a period of time, such as midterm and final exams. Summative assessment is what most standardized tests are used for. They are not designed to give immediate or continuous feedback, but rather to give an overview of what has been learned to that point. Most examination boards use this method of assessment so that students can be graded according to their performance in the summative assessment. [9], adds that summative

assessment which can be administered during the presentation of a course as a means of checking on student learning. [11] , posits that summative assessments are formal assessments conducted at the end of lessons, projects, and/or course to evaluate the learning achievement. Summative assessments are graded and are reflected in the final course grade. Examples of summative assessments include papers, quizzes, tests, and synthesis projects [11].

Formative assessments entail sampling student learning and providing feedback to guide the learning process [11]. Formative assessments can be anonymous surveys or they can be individual or group learning activities. In all instances, feedback rather than grading is the ultimate goal [11]. According to [12] an essential component of formative assessment is feedback. Feedback assists the students in identifying gaps in their knowledge and guides them towards measurements to close these gaps. In as much as feedback is crucial in formative assessment, there are different levels of feedback for example there is feedback about results, feedback about mistakes and feedback about processing thus showing different levels of formativeness. Formative assessments allow the instructor the opportunity to modify the teaching plan and learning experience in order to meet the learning outcomes [13] [11].

In both assessment methods, the teacher assumes two different roles. In the case of formative assessment, the teacher plays the role of a coach and facilitator so as to boost students' learning; but in summative assessment, teacher performs the role of a judge about students' attainment at a given period. Within any assessment system, question types may vary. Questions may include short essay type questions, true or false type questions, or multiple-choice questions. From discussions above it is quite clear that formative assessment is the best assessment model since it promotes learning on the part of the student and multiple choice style of questioning falls under summative assessment since it only gives feedback in form of an average mark scored. Many studies undertaken over the past years have demonstrated that formative assessment can be effectively supported by utilising web-based computer environments [12].

However, we can react to the demand of shifting attention towards formative assessment by building repositories that contain essay-type assignments and formative feedback annotations. This is in contrast to components widely available in current learning management systems that focus on multiple choice-style tests representing summative assessment [12]. Characteristic of formative assessment is that it requires open-ended response from the students and that multiple-choice style tests therefore are not sufficient. As a consequence, automated marking is not possible and the assessment specifically in this context, the feedback has to be provided by a human marker. In this paper, we look at the design of web based assessment ontology different from most of the researchers that is used to mark *Shona* words and phrases as a way of formative assessment and determine if the web assessment ontology mark as close to the human examiner.

3. METHODOLOGY

The research used an experimental design and survey of two primary schools (*Chipindura* and Hermann Greimer) in *Bindura* town, Zimbabwe to examine the differences in marking between the primary school teacher 9human examiner) and the ontology web assessment tool. The two schools were considered for the research due to the adequate reliability and functional computers as well as accessibility to the researchers. A web assessment ontology was designed and used by students. Interviews and questionnaires from teachers and pupils were used to gather data on marking and assessment as well as comparisons with the two formats on performance assessment.

3.1Design of the Web Assessment System

The WAS online learning platform was designed and programmed by the researchers with the view to make online assessment intelligent and preserve the human aptitudes when assessing students. The system implemented ontology as a basis for its assessment. Web Protégé was used to build the ontology and it was integrated with Mysql and PHP to support the development of Web assessment system. Design was done using the Use-Case modeling technique where three modules: the student module, the teacher module and the administrator module are present.

The Web Assessment Tool (WAS) was designed mainly to focus on assessments involving textual answers where the marking tends to be a complex process. All of the systems reviewed above do not cater for typing errors made by students neither do they replace the instructor in the marking process; but however, this is replaced by an intelligent entity. Errors which students do not need to be penalized for were incorporated and would be detected, that is the system was able to distinguish between a wrong answer and a spelling error with the right answer. To do this the system used comparison algorithms to compare the answers given by the tutor (examiner) and those generated by the system to the answers given by the student. The system has an option on the level of leniency which can be set by the tutor. The system also generated its own answers using those given by the tutor, this is done by using the answers given by the tutor to query the

ontology based electronic dictionary. The use of the ontology based electronic dictionary gives the system an edge over other systems of the same type. The ontology based electronic dictionary can be edited and reused which implies knowledge reuse.

This approach has several educational advantages. First, the dictionary serves as a useful cognitive tool to extend memory and ease of information processing, by allowing a learner to express meanings and relations directly. Secondly, the grouping of words is also cognitively meaningful, as grouping makes clear the common features and differences between groups. With the incorporation of the dictionary the problem of synonyms was easily addressed. Other features of the assessment system and ways it can change the assessment process as whole and its effect are:

1. The marking process is redundant, the same template (marking scheme) can be used for marking each and every paper, though a sense of intelligence is required, a system possessing a knowledge base can execute the very same process as the examiner and much faster with a greater degree of accuracy.
2. With the current way of assessment, examiners take longer time in assessing and marking candidates performances from the beginning of the assessment to the end, everything is done serially (especially during marking were each answer sheet is marked one at a time one after the other). Now with the implemented system, there is parallel processing of the assessment.
3. Introducing e-learning of this criterion in schools enforces computer literacy and also positively increase student's interests in computer related activities to a large extent in the long run.
4. The system can also be used in interviews where the interviewee might be required to take a short assessment, which makes it easy also to know which individuals have basic computer skills as these are essential at almost every level of profession these days.
5. A system with this level of artificial intelligence would increase the student's confidence in using such assessment systems.
6. This will save as a yardstick study towards bringing intelligence to the system.

3.2 Research Participants

The experimental design was made up of 60 students drawn from two primary schools in *Bindura.* The pupils are normally put in grades from grade zero up to grade seven, of which each grade consists of three classes A, B, and C. 30 students from each primary school doing grade 4 were selected at random. Each class i.e. 4A, 4B and 4C had 10 students. Random sampling was used to select the ten students by using a hat were the students would pick papers numbered one to ten and if you pick a paper numbered from one to ten you would qualify for the experiment to reduce sampling baise. Grade four pupils were chosen to participate because the pupils were computer literate since most primary schools introduce their pupils to computer studies at grade three. Each class had its own class teacher and had their own time-table to use the computer laboratories. The students followed their normal time-table to use the computer laboratories which had 30 minutes computer laboratory session per day for five days. The teacher was the implementer and facilitator of the WAS project. The teacher also helped in guiding the students in the process of learning.

The primary school students were given a *Shona* (local language) test which they wrote manually on their scripts and their respective teachers manually marked the scripts and recorded the results. The same test was applied to the web assessment system and the same answers which were manually marked were entered to the system to automatically mark. The results from the system and the results manually marked by the teacher were analyzed using the paired t test because the sample size was less than thirty and there was one variable which is student marks with two pairs to be tested i.e. teacher mark and computer mark.

4.   RESULTS AND DISCUSSION

The experimental design was done to answer the following research questions.

4.1 Can ontology based web assessment systems mark as human examiners?

In order to answer this research question, the researchers performed pair wise t-test in order to determine whether there was any significant difference in the marking of the human examiner and the web assessment system.

The following hypothesis was defined:

- $H_{0:}$ If Human leniency and careful judgement is imitated, web assessment systems can assess as human examiners do **OR**
- $H_{1:}$ Whether Human leniency and careful judgement is imitated or not web assessment systems will never match human examiners.

        The one sample paired t-test yielded the following descriptive group statistics for the grade 4 students who participated in the research. The Table 1 below shows output for one sample paired t-test carried on to assess the null hypothesis at 5% level of significance.

Table 1. T-test results for grade 4 pupils

	Mean	N	Std. Deviation	Std. Error Mean
TEACHER MARK	11.80	60	4.933	.637
COMPUTER MARK	11.63	60	4.787	.618

The Figure 1 show charts that shows the distribution of the marks awarded by the human and computer examiner to the grade four tests.
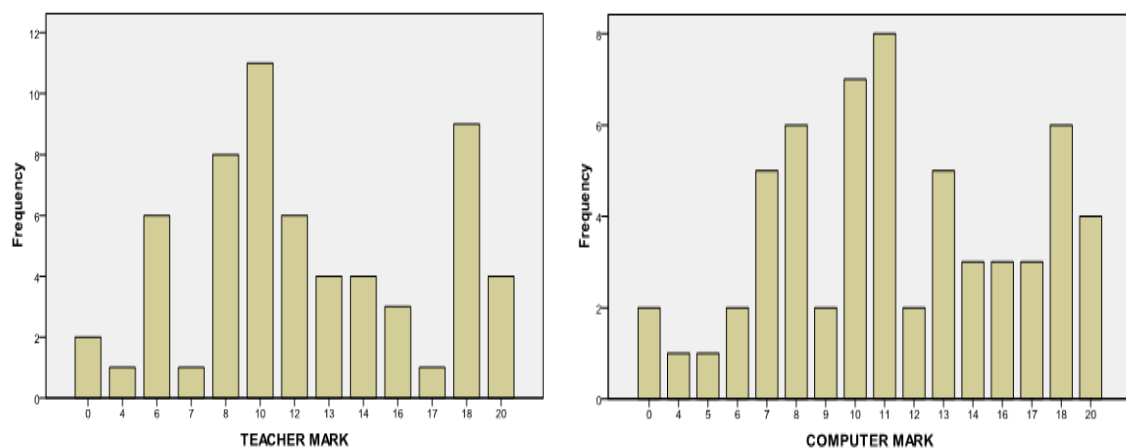

Figure 1: Human mark vs. Computer mark distribution

        Table 1 indicates that the mean teacher mark is 11.80 and the mean computer mark is 11.63 which show that there is a small difference between the means and implies that the computer mark from the web based system is not far away from that of the human examiner. This means that the mark obtained by the student in the exam does not dependent on the evaluation method used, that is, the student obtains the same mark by using manual examiner or system examiner. This is also suggested in figure 1 above which shows that the mark distribution of the human examiner and that of the web assessment system are almost the same. Table 1 also answers research question two since it shows that web assessment system is more accurate than the human examiner because the standard error mean of a computer is far much less than that of the human examiner which is 0.618 compared to 0.637.

        The Table 2 below shows correlation between teacher mark and system mark and it can be deduced from the Table that there is highly positive correlations between the teacher mark and the web based computer mark since we can see that r=0.968 and p value =0.000.

Table 2. Paired sample correlations.

		N	Correlation	Sig.
Pair 1	TEACHER MARK & COMPUTER MARK	60	.968	.000

4.2   Results from questionnaire survey

A questionnaire was distributed to all the six grade four teachers who were involved in the research to capture their perceptions towards the implementation of the web assessment system.

4.2.1 What do you prefer when marking?

According to the responses obtained from the questionnaires, four out of six teachers i.e. 67% indicated that they prefer the web assessment system when marking and only about 33% opted for the human examiner to mark the scripts. Teacher preference on the method of marking to be used is vital component of an exam system, the teacher will concentrate more on teaching side since all processes taken on exercises or tests are taken care by the system and importantly pupils are assessed more frequently than using manual method of assessment.

4.2.2 Is the computer system educative to students?

This was a direct question, with 100% agreeing that the exam report was educative more than the one prepared by the human examiner. It included question number, question, possible answers, and answers of the relevant student, marks awarded per question and the overall percentage mark. This is important for revision purposes and any queries that may arise. Providing such a report will increase students' confidents in using such systems.

Table 3. Is the web assessment system educative.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	6	100.0	100.0	100.0

4.2.3 How do you rate the computer system being adopted with other schools from 0 to 5?

Out of a likert scale of 0 up to 5, 50% of the respondents rated the system 3 out of 5, 17% rated the system 4 out of 5 and 33% rated the system 5 out of 5 as shown below. This shows that all the respondents advocated for the adoption of the system in other schools which shows a high rate of acceptance of the web assessment system.
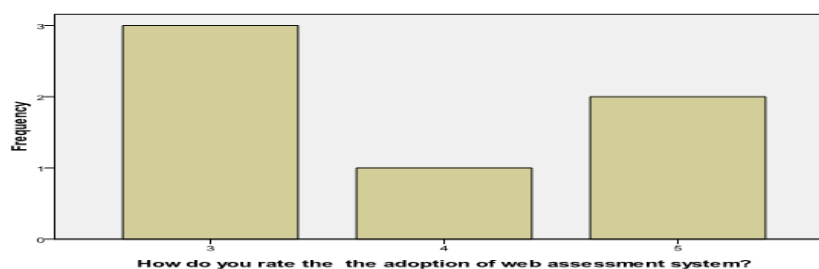

Figure 2: Adoption of Web assessment system

4.2.4: In your opinion do you think the computer system will solve challenges faced with teachers to deliver their marking?

Eighty three percent of the teachers agreed that the system will solve challenges faced with teachers in executing their marking duties as compared to 17% who said no as shown in the pie chart below. The response was favorable because the web assessment system reduces the marking workload and this will go a long way in promoting learning since teachers will now be concentrating with the teaching aspect only.
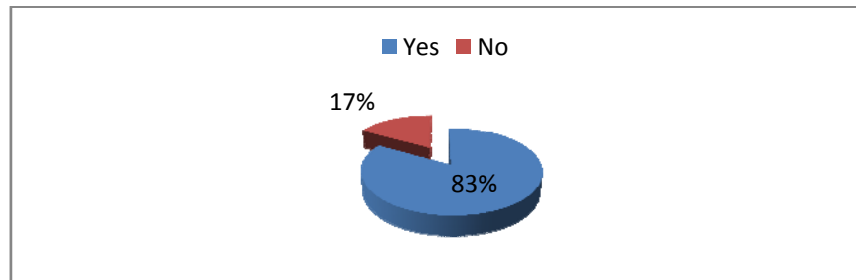
Figure 3. Pie chart showing opinions

4.2.5 Overall comments by respondences

Though this was an open question, the responses were put into classes and recorded as shown below. 96% of the respondences said it was a beneficial system but some gave recommendations. Comments like 'should cater for all subjects', length of textual answers too short, most teachers said the system encourages all students who cannot afford to pay private tutors.
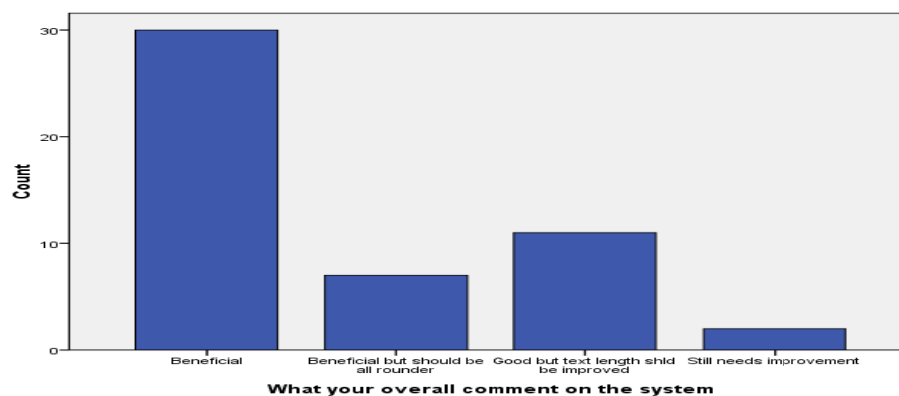

Figure 4: Overall comments

4.3 Interviews

Interviews were conducted with pupils and teachers to capture their respective opinions on the effectiveness of the web based system and also answer research questions three and four.

4.3.1 Do you agree if human intelligence is imitated on assessment systems, it can actually mark as human examiners do.

Out of all the sixty respondents made up of twenty five females and thirty five males, 57% agree to the above question, 12% strongly agree, 23% are neutral, and 8% disagree. This shows that ultimately 69% percent support the idea that if human intelligence is imitated web assessment systems can actually mark as human examiners do although there are 23% who are neutral on the idea and most of the neutral respondents are females as indicated in the cross tabulation Table 4 below.

Table 4. Do you agree if human intelligence is imitated on assessment systems, it can actually mark
as human examiners do

		do you agree if human intelligence is imitated on assessment systems, it can actually mark as human examiners				
		disagree	neutral	agree	strongly agree	Total
what is your gender	female	5	10	10	0	25
	male	0	4	24	7	35
Total		5	14	34	7	60

4.3.2 How do you rate the leniency of the system as a percentage?

Eighty eight percent of respondences rated the systems leniency to be above 50% with the remaining 12% rated it to be below 50%. This showed that though leniency as a subject is a debatable and subjective, people have different views on it but after all have used the system, they thumped up this same subject that is has been thoroughly looked into and implemented correctly. Table 5 below shows a cross tabulation of a summary of how the question was answered.

Table 5. How do you rate the leniency of the system as a percentage Cross tabulation

Count

		how do you rate the leniency of the system as a percentage				
		0-25%	26-50%	51-75	76-100	Total
what is your gender	female	3	4	18	0	25
	male	0	0	4	31	35
Total		3	4	22	31	60

4.3.3 Do you agree that on setting the examination the possible answers provided by the system were useful

As shown by Table 6 below 88% of respondents agreed that system generated answers were useful during setting an exam with many indicating that they were also educative to the examiner. Since the examiners have the control that is can change or add more possible answers if he or she wishes to, make the system more flexible and useful.

Table 6. Do you agree that on setting the examination the possible answers provided by the system were useful

Count

		do you agree that on setting the examination the possible answers provided by the system were useful		
		Yes	no	Total
what is your gender	Female	3	1	4
	male	2	0	2
Total		5	1	6

4.3.4: Do you prefer your school to use the system

Out of the 60 pupils who were interviewed 67% preferred the system to be used at their school which shows that the system was useful and effective to the pupils although 33% of the students answered no as shown below.

Table 7. Do you prefer your school to use the system Cross tabulation

Count

		do you prefer your school to use the system		
		yes	no	Total
what is your gender	female	12	13	25
	male	28	7	35
Total		40	20	60

4.4 Discussion

Analysis of the results from research questions mentioned earlier above indicated that web assessment system leads to optimistic improvements in the student's assessment because it is more accurate as compared to the human way of assessment as indicated in the t-test results. Ontology based online assessment showed that it can assess just like the human examiner does but goes further by offering some aspects of learning because it produces an educative report at the end of each test or exercise given to students as indicated by results above.

Results from the research indicated that ontology web based assessment systems provides possible answers which are very helpful to students in their learning process. The results shown above shows also that if ontologies are incorporated in the online assessment, can become lenient and judgmental just like the human examiners. The development of such a system was a step further in regarding to assessment systems marking textual answers. Maximum text length permitted remains a major setback, future studies must concentrate more on increases of text length permitted that is having web assessment system that assess essay answers will be a great stride forward.

Further study should be done in wider implementation of ontology based dictionaries whereby both answers from the examiner and answers from the student are both used to query the ontology, the end result being a marking process whereby is a comparison of semantics resulting from both data sets. This would still work for a system that takes in textual answers in the form of small sentences but would still need to implement rule sets for the marking module. Also development of ontology based dictionaries relevant for each field would be a great advancement as it eliminates the need for answer verification for example an ontology based dictionary for terms used in medicine only the result being assessment systems relevant only to a specific system but more efficient.

5. CONCLUSION

The development of an assessment system that implements ontology based electronic dictionary when marking, was successful. The results were positive both from the pupils and the respective teachers although there were some sections which needed refinement. It was noted that incorporating ontologies in answer generation improves online assessment systems so much that the assessment is more of a human examiner. Ontologies maintains the traditional way of assessment i.e. using structured questions and also preserves the human aptitudes like lenience and judgement in an online examination system.

The model system is recommended for use in learning institutions like schools and institutions of higher education, because of its simplicity combined with its ability to handle complex words .The system has minimum security features making it less efficient in terms of user authentication over the internet, and would therefore need an upgrade in this regard. The system can also be used in interviews making it easier to test an individual's knowledge at the same time testing the individual's basic computer literacy. When this system is implemented at an institutional level it is recommended that examiners keep updating the ontology based electronic dictionary to suite word meanings that might be relevant to the courses offered by the institutions and these words can be in any language; this would contribute to the gradual growth of the ontology making it more useful.

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