The mediating role of assessments in the development of problem-solving skills in university students

Norman Rudhumbu[1]
Faculty of Science Education, Bindura University of Science Education, Zimbambwe
nrudhumbu@buse.ac.zw; nrudhumbu@gmail.com

Sreedevi Iyer[2]
Faculty of Computing, Botho University, Botswana
sreedevi.iyer@bothouniversity.ac.bw

Abstract

The purpose of the study was to examine the mediating role of assessments in the development of problem-solving skills in university students at a selected university in Botswana. The study was specifically an attempt at identifying assessment strategies and question types that promote the development of problem-solving skills in university students. As part of the study, challenges which are faced by lecturers that militate against the development of assessments for the development of problem-solving skills in students were identified. The study used samples of 438 students and 108 lecturers selected using a stratified random sampling procedure to collect data about the role of assessments in the development of problem-solving skills in university students. A structured questionnaire that used a 5-point Likert scale was used for data collection. Collected data was analysed using SPSS version 24. Results of the study showed that assessment strategies that include practical examinations, projects, portfolios, quizzes, short tests, in-class assessments (ICAs) and written examinations can be used to develop problem-solving skills in students, while oral presentations do not develop problem-solving skills in students. It was also found that assessment type questions that include essays, case studies, short answer and assertion/reasoning questions could be used to develop problem-solving skills in students, while assessment question types such as multiple choice, fill-in the blanks, matching and true or false do not lead to the development of problem-solving skills in university students. Results of this study will play a significant role in conscientising university lecturers on the types of assessments which can be used for the development of problem-solving skills in university students.

Keywords: assessments, problem-solving, students, development, assessment strategy, question type, university

Introduction

Assessments are an important part of higher education quality assurance as they determine the extent to which learning is taking place. They not only act as a measure of academic standards, but also play an inevitable role in molding student behavior and their future (Higher Education Academy, 2012). Assessments can motivate students to study (Quality Assurance Agency for Higher Education (QAA), 2012; Stassen & Doherthy 2001). Assessments are a continuous process throughout higher education and make the higher education sectors' expectations

---

explicit to the learners. Assessments are structured with the aim of setting high standards of quality in learning. They represent a constructive process which involves collecting assessment evidence for every learner and comparing their achievements against set expectations. From a higher education view point, the outcomes of quality assessments are not only restricted to student success, but also to creating a "shared academic culture", which can in turn lead to improvement of quality in higher education (QAA 2012).

Research shows that problem-solving skills equip students to encounter and solve problems in their professional and personal lives. In his study on the development of problem-solving skills in university students, MacDonald (2014) found that problem-solving skills help students to be confident, creative and effectively manage change, while Mills and Kim (2017) also found that students with a high degree of problem-solving skills are able to solve complex and sometimes complex challenges they face in their everyday lives. Graduates with such abilities are proven "skilled thinkers" and "innovators" who can be a worthy addition to the global economy. Consequently, national and international bodies are urging universities to produce graduates who have the knowledge and skills to solve problems in varied contexts. Research shows that this skill also finds expression in employability, since employers now look for varied problem-solving skills such as creativity, innovation, practicality, independence, team playing, among others in university graduates (Crebert *et al*. 2011; Darling-Hammond *et al*. 2013). This study therefore focuses on assessments and their role in the development of problem-solving skills in university students.

Universities the world over use different types of assessments when seeking to establish the learning progress of their students. Such assessments include practical examinations, projects, portfolios, quizzes, short tests, in-class assessments (ICAs), written examinations, essays, case studies, short answer and assertion/reasoning questions. Despite having a multiplicity of these assessments types, there is no study known to the researcher that has been conducted, in the context of Botswana, to establish which of these assessment types can be used to develop problem-solving skills in students. This study therefore is an attempt to fill the research gap on the role of assessments in the development of problem-solving skills in university students as well as on the challenges lecturers face when developing such assessments.

Research questions
1. What are the views of students and lecturers towards the role of assessments in the development of problem-solving skills in university students?
2. Which assessment strategies and question types can be used in universities to develop problem-solving skills in university students?
3. What factors related to assessment act as challenges to the designing and implementation of assessments for the development of problem-solving skills in university students?

Literature review and theory
This study aimed at establishing assessment strategies that can be used to develop problem-solving skills in university students, hence it is informed by the dynamic assessment theory whose focus is on problem-solving abilities through assessments. The dynamic assessment (DA) theory is defined as an "active teaching process", which continually assesses a student's perception, learning, thinking and problem-solving skills (Rahbardar, Abbasi & Talaei 2014). Among some of the objectives of the DA theory are (i) assess student's grasping capacity, (ii) assess the amount of teacher time investment to make the student understand concepts, (iii) identify any cognitive functions that are deficit in students, and (iv) identify "special factors" (impulsivity, planning behavior) that are not related to intelligence that lead to student failure to develop critical thinking and problem-solving skills. This theory helps lecturers understand

cognitive problems of students which act as barriers to the development of problem-solving skills in students (Rahbardar, Abbasi & Talaei 2014; Birjandi, Estaji & Deyhim 2013). The DA theory is viewed as a framework that integrates teaching and learning to understand learners' cognitive abilities, and appropriate actions to facilitate effective learning process (Birjandi, Estaji & Deyhim 2013; Lantolf & Poehner 2010; Lantolf & Poehner 2010; Malmeer & Zoghi 2014). DA also suggests that some learners can achieve learning outcomes at a faster rate than others, and hence learners' pace of learning is very crucial to their success. It is also noteworthy that a student's performance on one assessment is not enough to generalize the abilities and skills developed by the student. Mediation should be appropriately utilized to assist students from failure (Lantolf & Poehner 2010; Ozgur and Kantar 2012). In the next section, the paper focuses on the concept of assessment, and the nature of assessments that can be used for developing problem-solving skills in university students.

2.1 The concept of assessment

According to McCulloch (2007), the term "assessment" is derived from the Latin word *ad sedere*, which refers to the procedure that is used to assess/measure student learning. Assessments provide insight into (i) the concepts that students consider as important, (ii) time spent by students for academic purposes, and (iii) the perspectives of students about themselves (McCulloch 2007). An important definition of assessments is suggested by The Quality Assurance Agency for Higher Education (QAAHE) (2012) which avers that assessment is the process that "appraises" students' knowledge, content understanding, abilities and skills that are required to pursue their future careers. Assessments therefore form a very crucial part of higher education not only for students, but also for teachers and the society. Assessments provide students with feedback, help them to identify their strengths and weaknesses, and encourage them to successfully complete the programmes (McCulloch 2007; Fletcher *et al*. 2011; Spiller 2012; QAAHE 2012; Sotardi and Brogt 2016).

2.2 Challenges in designing assessments for developing problem-solving skills

Assessments that appropriately test the learning outcomes and also promote the development of problem-solving skills in students are not easy to design. Some of the major challenges faced by many higher education institutions in this regard are (i) uncertainty on what to measure, (ii) lack of commitment showcased by institutional leadership, (iii) lack of commitment from faculty, and (iv) difficulty in identifying valid and reliable assessment instruments (Nunley, Bers & Manning 2011). Apart from the general issues stated above, there are more serious and overlapping concerns for higher education institutions in terms of designing and implementing assessments that develop problem-solving skills in students. Some of these diverse challenges in executing effective assessments are identified by Nunley, Bers and Manning (2011), explained as follows:

i. higher education institutions have multiple missions – students enter higher education with varied expectations like acquiring a degree or transfer, understanding the content, and/or obtaining the programme credentials. These varied expectations from the students necessitate different approaches to assessing student learning;

ii. student characteristics – students in higher education possess varied characteristics such as pre-college level reading and writing skills, not adhering to the right path of developmental courses like math, irregular attendance, difficult economic and family conditions, dropping out of college, etc … that make assessments difficult to design and execute if each of these students' needs are to be satisfied;

iii. scarcity of qualified staff – Faculty members who are qualified and skilled enough to design assessments that effectively assess learning outcomes are limited in most of the higher education institutions;

iv. limited funds – many higher education institutions do not have enough funds to cover assessment development costs to provide appropriate stipends to the faculty involved in the process;

v. time constraints - in many cases faculty members in higher education institutions are not provided adequate time to effectively develop assessments;

vi. less engagement from faculty members as a result of a wide range of barriers that result in low faculty interest to carry out assessments and which according to Emil (2011: 49) include: (a) time constraints due to teaching work load, (b) lack of skills and knowledge to conduct effective assessments, (c) faculty lacks support and encouragement from administration departments, (d) part-time faculty members may not undergo training on assessments, and (e) limited use of technology to support effective assessment development;

vii. adjunct faculty's involvements in assessment – Such faculty members often conduct evening lessons and are not available during the discussions about assessments, and it might become difficult to reach the outcome of discussion with clarity to them; and

viii. higher education institution's policies and practices regarding assessments – lack of interest and involvement from higher authorities within and outside the institutions can create low motivation in faculty members, thus affecting their willingness to create and execute effective assessments.

To construct and conduct good assessments at University, Sotardi and Brogt (2016) suggest that knowledge resources are very important. Knowledge resources are the knowledge the student will gain through the module content and educational experience during the course of study. These include discipline specific skills (also known as transferable skills) which are competent in nature such as self-management skills (like critical thinking and problem-solving), content specific information and knowledge, and task specific skills (Sotardi and Brogt 2016). These skills can be a deciding factor with regards to the nature of student results.

2.3 Types of assessment methods

According to SQA (2015), choosing appropriate assessment methods is crucial to student learning, and requires professional expertise and knowledge in terms of module content and important skills students should develop. Some of the commonly used assessment methods that enhance problem-solving skills are assignments, case studies, professional discussions, projects, simulations, work-integrated learning, and work-based learning (Derrell 2015; SQA 2015).

Once an assessment method has been chosen, the next step in setting a good assessment is to understand the different types of questioning techniques available. The choice of questioning techniques will depend on the benefits and challenges of each of the types of questions. According to SQA (2015), the questioning types that enhance the development of problem-solving skills are assertion/reasoning, essays and short answers. Other types of questions such as true/false, matching, grid, multiple choice, restricted response and structured questions are shown as not being capable of developing problem-solving skills in students (SQA, 2015).

From the above discussions it is evident that assessment criteria and scheme must be considered as very crucial elements of any assessment. This is because assessment criteria define the knowledge, skills, and other qualities that need to be assessed. Ulster University (2016) posits that assessment criteria should also provide clarity on the standards of achievement for every grade or mark. Marking schemes, on the other hand, provide clarity on the strategies to award marks for every element of performance. The Quality Assurance Agency for Higher Education (QAA) (2012) provides two important measures to be considered when choosing assessment methods: (i) Mixing assessment methods is very effective to not only

provide students with varied assessment experiences, but also to null-out the biases involved in one assessment method, and (ii) use of more and more formative assessments to help students effectively satisfy the learning outcome.

It is interesting to note that O'Neill (2011) suggests providing an opportunity for students to choose assessment methods. In his book he argues that this will make them competent in decision-making on how and what they learn. This paradigm is known as an "inclusive approach to assessment" as it allows the students to choose assessment questions, criteria, topics, etc. at module level (SQA 2015).

2.4 Problem-solving skills

According to Hains-Wesson (2015), problem-solving skills relate to a student's ability to critically analyze and solve both real and ill-defined problems. These skills can be defined as the abilities to (i) understand the problem, (ii) use appropriate tactics or methods to solve the problem, (iii) monitor the methods and reflect on the observations, (iv) prioritize accuracy to speed, (v) risk and cope with ambiguity, etc. (Kim and Choi 2014). Laterell (2013) argues that problem-solving skills represent the ability to solve an unfamiliar problem with no particular constraints. For instance, it does not consider whether the method of solving is known to the solver.

Higher Education should not only educate students on the content, but also inculcate some of the soft skills that will prepare the young graduates to (i) perform jobs of tomorrow, (ii) work with technologies that are always emerging, (iii) live, think and learn in a way they are not yet familiar with (Griffin 2015; Hains-Wesson 2015; Tremblay, Lalancette & Roseveare 2012). Research shows that problem-solving skills represent the most important characteristic of a young graduate in the employment market. This is because most of the employees in the work place are confronted by a variety of problems related to work that need thinking before acting. This has eventually led to the parents and employers suggesting that higher education institutions develop problem-solving skills in graduates (Organization for Economic Co-operation and Development (OECD) 2014; Griffin 2015).

Problem solving skills not only lead to the mastery of content, but also go beyond, to make students (i) motivated, (ii) obtain a deep understanding of the content, (iii) learn independently and collaboratively, (iv) obtain higher-order cognitive skills, and (v) develop other skills such as critical analysis and communication (Fry, Ketteridge and Marshall 2009; Antonenko, Jahanzad and Greenwood 2014). Results of a study by OECD (2014) show that, among all students in OECD countries, only 5% are able to solve problems, and that too, only if problems are straightforward and familiar.

2.5 Designing assessments that develop problem-solving in students

Shabani, Khatib and Ebadi (2010) argue that traditional assessments only evaluate fully matured abilities and leave out those abilities, such as problem-solving skills, which are in the developmental phase. Therefore, refocusing traditional methods of assessment like examinations, research essays, projects or laboratory reports, is required to align them with real-world problems will help to develop problem-solving skills in students (Crebert *et al*. 2011). Moreover, there are assessment methods that can assess if the students are indeed able to solve real-world problems, and these include case studies, group discussions, work-integrated learning and work-based learning. Heins-Wesson's assessment rubric for problem-solving skills articulates six steps which include (i) identification of the problem, (ii) defining the problem, (iii) examining the solutions, (iv) acting on a plan, (v) analyzing the consequences, and (vi) testing the outcome (Hains-Wesson 2015).

Swartz and McGuinness (2014) propose two approaches for assessing critical thinking and problem-solving abilities, namely the psychometric and curriculum approach. Psychometric or testing approach perceives critical thinking as a characteristic of students and promotes single testing of skills. This approach relies on multiple choice questions. On the other hand, the

curriculum approach views thinking as an ability that develops during a specific learning context, and hence argues that assessment of thinking and development of problem-solving skills will depend on the quality of students' work.

3. Methodology

The study employed a post-positivism paradigm that used a quantitative approach. Post-positivism argues that knowledge is conjectural and that absolute truth can never be found (Creswell 2015). As a result, this paradigm works on the belief that evidence established in research is always imperfect and fallible and hence is open to continuous improvement. A descriptive design that used a survey was also used in the study.

Population and sampling

The study population or target population refers to the group of people or objects that are affected by the research findings (Hanlon and Larget 2011). This study aimed at finding out whether university assessments develop problem-solving skills in students. As a result, the target populations for this study were the two categories of respondents, namely university students who take part in the assessments and lecturers who are responsible for setting, executing and marking the assessments at the four selected universities.

A study sample refers to the group of people selected from the population for data collection purposes especially where the population of the study is large (Hanlon and Larget 2011; Meng 2013). We used stratified random sampling strategy to select 108 lecturers and 438 students from 132 lecturers and 1615 students respectively to participate in the study. Stratified random sampling technique is a method of partitioning the population into regions or strata, so that a sample is drawn from each stratum using simple random sampling (Meng 2013). The total of these samples from the different strata gives the study sample. The 4 selected universities had four faculties with different numbers of departments, and each department consisted of different numbers of lecturers and students. This sampling technique enabled us to select lecturers and students proportionately.

Data collection instruments are defined as fact-finding instruments used for collecting data (Zohrabi 2013). This research used structured questionnaires for data collection from lecturers and students. Structured questionnaires consist mostly of close-ended questions and have pre-coded answers, and are best used for comparing the responses of many people (Mathers, Fox and Hunn 2009). This method is most commonly used for quantitative research that involves computations using numbers. Structured questionnaires are helpful to reach a large group of people quickly, and are relatively easier to create. Moreover, it is easy to address embarrassing, confidential areas. However, the format of such questionnaires makes it difficult for the researcher to explore complex issues and/or opinions. It relies a lot on the respondents' understanding of the questions, and hence requires the researcher to frame questions in such a way that both the questionnaire constructer and the reader perceive them in the same way. The response rate is also generally low with this method, and this may worsen if the questionnaires are distributed through a postal system (Harris and Brown 2010).

This research used structured questionnaires to gather data for understanding the perceptions of lecturers and students. Structured questionnaires were especially beneficial here since the target group was large and the respondents were likely to provide unbiased, correct opinions in an anonymous structured questionnaire. Before administration, the questionnaires were tested for internal consistency reliability and content validity. With regard to internal consistency reliability, Cronbach's alpha index was found to be 0.83, hence the instrument was found to be reliable enough for the study. With regard to content validity, the questionnaire was subjected to expert opinion and contributions from the experts were incorporated into the questionnaire before administration. With regard to lecturers, 108 questionnaires were distributed and 87 were returned, making a return rate of 80%. With regard to students, 438

questionnaires were distributed and 375 were returned, making a return rate of 85.6%. The 80% and 85.6% return rates were considered adequate since according to Nulty (2008), depending on the robustness of the study, 50 to 60% of response rate is adequate in on-paper surveys.

This research, as explained above, assumed a quantitative approach and the collected quantitative was analysed using SPSS version 24. As part of analysis using SPSS, statistical tools that include tables and graphs were used.

4. Presentation and analysis of results

This section deals with the presentation and analysis of data collected from both lecturers and students about the role of assessments in developing the problem-solving skills of university students. The section begins by analysing biographic factors of both students and lecturers then goes on to analyse data related to the perception of students and lecturers on the mediating role of assessments in the development of problem-solving skills in university students. For ease of analysis, the following key was used in some of the sections below: SDA – Strongly Disagree, DA – Disagree, N – Neutral, A – Agree, and SA – Strongly agree.

4.1 Analysis of demographic data

Demographic data of respondents was analysed in order to gain an understanding of the profiles of all the respondents. These profiles are important in helping decipher why the respondents or some of them held perceptions about assessments and the development of problem-solving skills the way they did.

Table 1: Demographic data of students

Item	Categories	Response %
Gender	Male	39
	Female	61
Age (years)	< 20	2
	20 – 24	82
	25 – 29	13
	– 34	2
	> 34	1
Level of study	7	48.2
	8	51.8
Qualification studies	Degree	95%
	Diploma	5%

Results in Table 1 show that there are more female students (61%) than male students (39%) at second year level in the university. This shows that, in terms of gender, the university may be admitting more female students than male students into its programmes. It is also shown in Table 1 that most of the students (84%) at the university are less than 25 years old while very few (3%) are aged 30 years and above. This may mean that most of the students at the university are still very young adults. It is further shown in Table 1 that of the second-year students who participated in the study, most are in the second semester (51.8%) while the remaining ones (48.2%) are in the first semester of their second year. Results of the study in Table 1 also show that most of the students (95%) are doing degree-level qualifications while very few (5%) are doing diploma qualifications. This may indicate that the university mostly admits students into its degree programmes rather than into diploma programmes.

Table 2: Demographic factors of lecturers		
Item	**Category**	**Response %**
Gender	Male	70
	Female	30
Age (years)	25 – 29	12
	30 – 34	21
	35 – 39	27
	40 – 44	16
	45 – 49	11
	50^+	13
Years of experience	0 - 4	16
	5 - 9	39
	10 - 14	17
	15 - 19	15
	20^+	13
Educational level	Professional Diploma, e.g. (CIMA)	7
	Bachelor's degree	8
	Master's degree	77
	PhD	8
Levels taught	7 (Year 2 semester 1)	48
	8 (Years 2 semester 2)	52

Table 2 shows that most of the lecturers at the university (70%) are male while female lecturers only constitute 30% of the total lecturer population teaching second year students. The above shows a lack of gender balance in the teaching staff at the university. Such an imbalance may have an influence on the overall perceptions of lecturers on the role of assessments in developing problem-solving skills in university students as views of many male lecturers may overshadow those of the few female lecturers.

Results in Table 2 also show that the age of most of the lecturers at the university (60%) is below 40 years while fewer lecturers (40%) are 40 years old and above. This may indicate that the university has a relatively young staff complement. It is further shown in Table 2 that most of the lecturers (55%) who teach second year students have less than 10 years of teaching experience while 45% of the lecturers have 10 years and more years of experience. This may mean that lecturers teaching second year students are still relatively new to the profession and still have a lot to learn about lecturing. It is shown in Table 2 that most of the lecturers (77%) teaching second year students possess masters degrees as their highest educational qualifications while only 8% of the lecturers are PhD holders and the rest (15%) are either bachelors or diploma holders. These statistics show that lecturers teaching second year students are relatively well qualified. Table 2 shows that most of the lecturers (52%) teaching second year students teach level 8 students while 48% of the lecturers teach level 7 students. This could be because, as shown in Table 1, the university has more level 8 students than level 7.

4.2 Challenges affecting the ability of lecturers to develop assessments that enhance problem-solving skills in students

This section discusses challenges faced by lecturers when designing assessments that develop problem-solving skills in students. Data from this section was viewed as important in generating an understanding of the complexity or otherwise of challenges university lecturers face and why they may or may not be able to effectively design assessments that develop problem-solving skills in students.
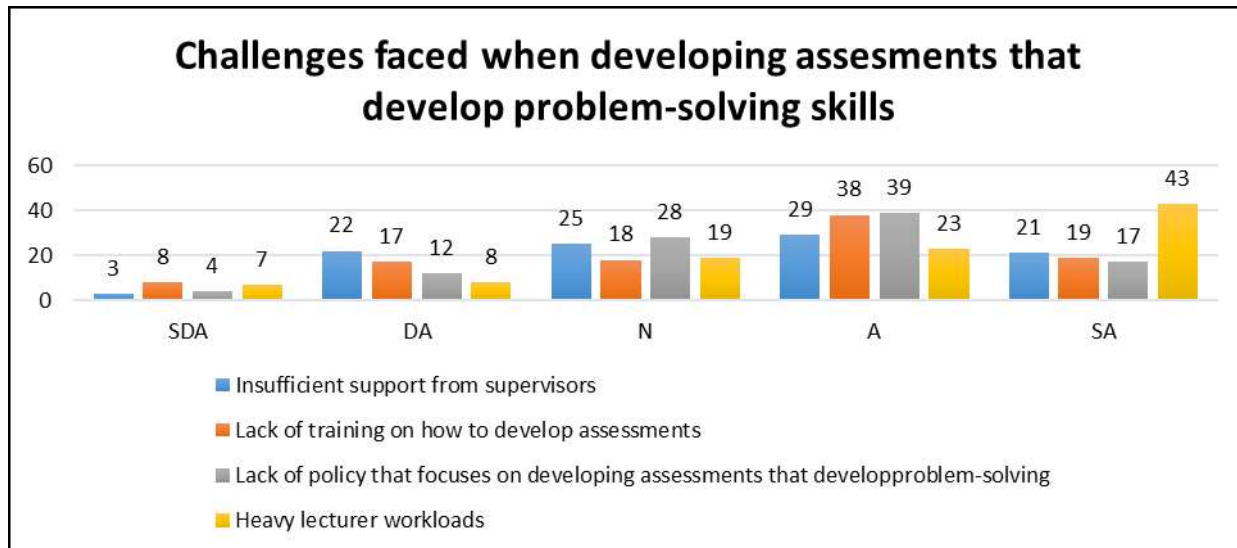
Figure 1: Challenges faced when developing problem-solving enhancing assessments

Figure 1 shows that lecturers face a number of challenges that affect their ability to develop assessments that develop problem solving skills in students. The main challenge lecturers face is heavy workloads (66%) followed by a lack of training on the development of assessments that develop problem-solving skills (57%), lack of policy in the institution that focuses lecturers' attention towards developing assessments that lead to the development of problem-solving skills in students (56%) and inadequate support from supervisors (50%). The issue of heavy workloads particularly is viewed as the greatest hurdle to the effectiveness of using assessments to develop problem-solving skills in students as teachers find no time to plan, design and effectively implement these assessments. Another main challenge in the university is lack of training on how to design assessments that are capable of developing problem-solving skills in students. Without training it means the lecturers do not have the knowledge and skills to handle issues to do with such assessments. The end result will then be students being subjected to assessments that mostly ask them to recall information instead of critical thinking and problem-solving.

4.3 Views of students on whether assessment strategies used by lecturers develop problem-solving skills in students

This section discusses perceptions of students towards whether assessment strategies their lecturers use help in developing problem-solving skills in students. This data was viewed as important in helping readers make judgements about how students view some or all of the assessments they participate in.
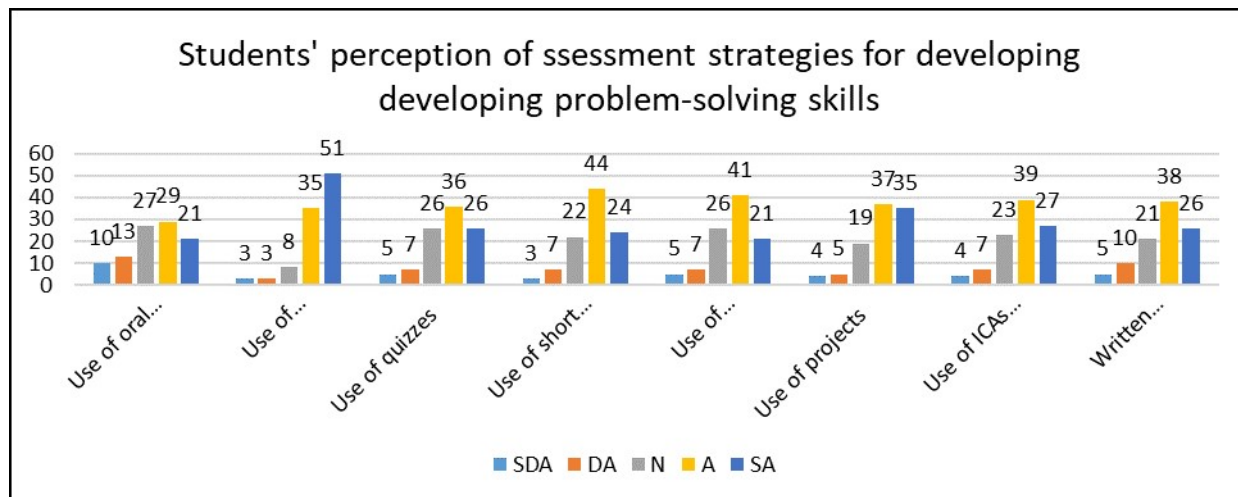
Figure 2: Students' perception of assessment strategies for developing problem-solving skills

Figure 2 shows that there was a general agreement among students that written examinations (64%), ICAs (66%), projects (71%), portfolios (62%), short tests (68%), and practical examinations (86%) are assessment strategies that can be used to develop problem-solving skills in students. Use of oral examinations (49%) was however not viewed as being capable of developing problem-solving skills in students. From the above it can be observed that practical examinations are the most accepted assessment procedure for developing problem solving skills in students.

4.4 Perception of lecturers on assessment strategies for developing problem-solving skills

This section presents an analysis of perceptions of lecturers on whether they feel assessment strategies they use help in developing problem-solving skills in students. A 5-point Likert scale from SDA to SA was used to collect data on lecturers about their views on assessment strategies and the development of problem solving-skills by students.
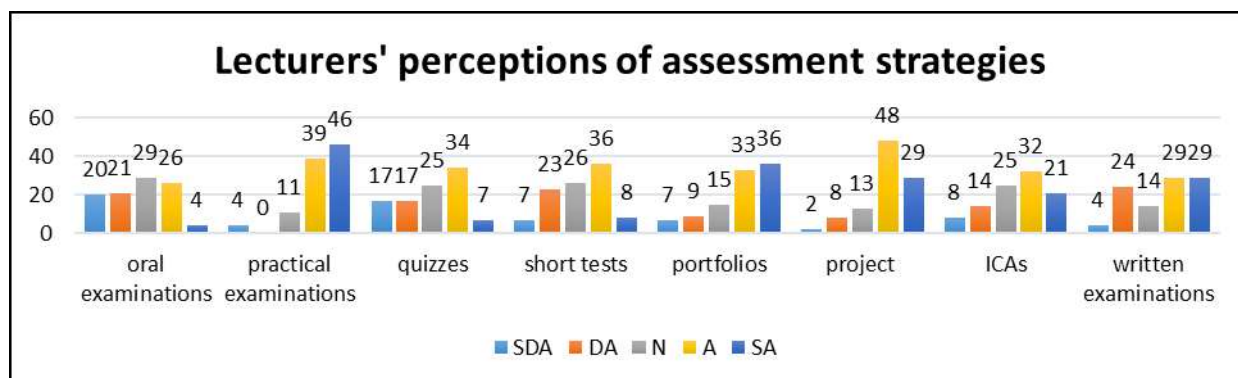

Figure 3: Lecturers' perception of assessment strategies for developing problem-solving skills

Results in Figure 3 show that lecturers believed that the following assessment strategies: practical examinations (85%), projects (77%), written examinations (58%), portfolios (69%) and ICAs (53%) can be used for developing problem-solving skills in students. At the same time, lecturers do not believe that oral examinations (30%), quizzes (41%), and short tests (44%) can be used to develop problem-solving skills in students.

4.5 Students' perceptions of assessment question types for developing problem-solving skills

This section analyses views of students on whether specific assessment question types help in developing problem-solving skills in students. A 5-point Likert scale from SDA to SA was used to

collect data on how students viewed the different assessment types that lecturers administer on them. This data was viewed as important in gauging whether students believed that the assessments they take part in were in developing problem-solving skills in students.
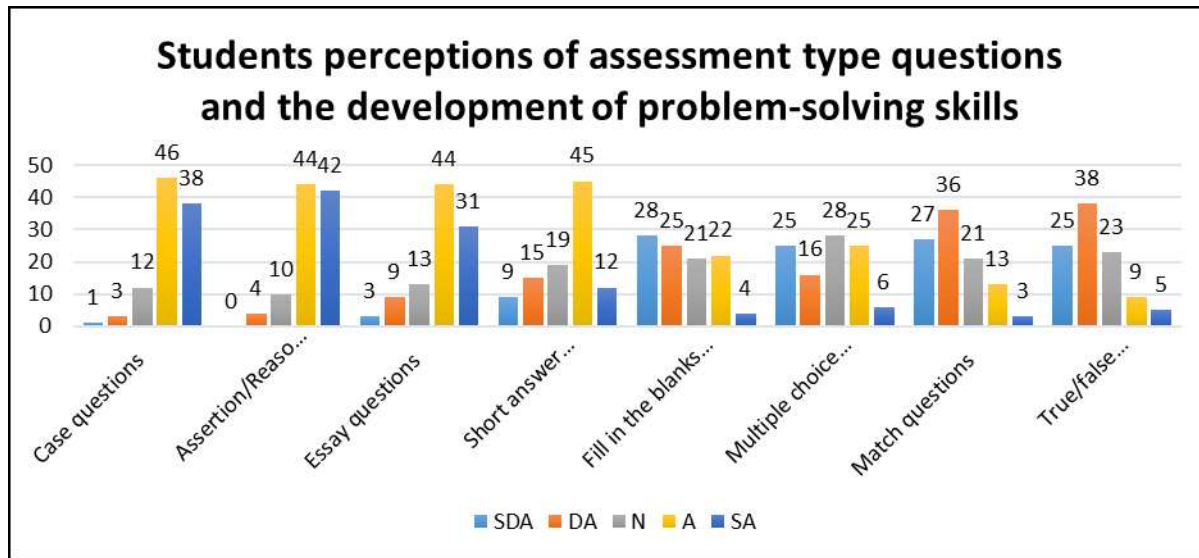

Figure 4: Students' perception of assessment type questions

Results in Figure 4 show that students believe that assessment type questions that include short answers (68%), essays (67%), assertion/reasoning (73%), and case studies (67%) can be used to develop problem-solving skills in university students. Students also believe that assessment type questions that include fill-in the blanks (47%), multiple choice (45%), match questions (35%), and true and false questions (39%) cannot be used to develop problem-solving skills in students.

4.6 Lecturers' perception of assessment type questions which develop problem-solving skills

This section analyses the views of lecturers on whether the different assessment question types they use develop problem-solving skills in students. A questionnaire that employed a 5-point Likert scale from SDA to SA was used to collect data from lecturers. This data was viewed as important in helped readers gain an understanding of how lecturers viewed and understood the importance of assessment types they set and administered in terms of the development of problem-solving skills in students.
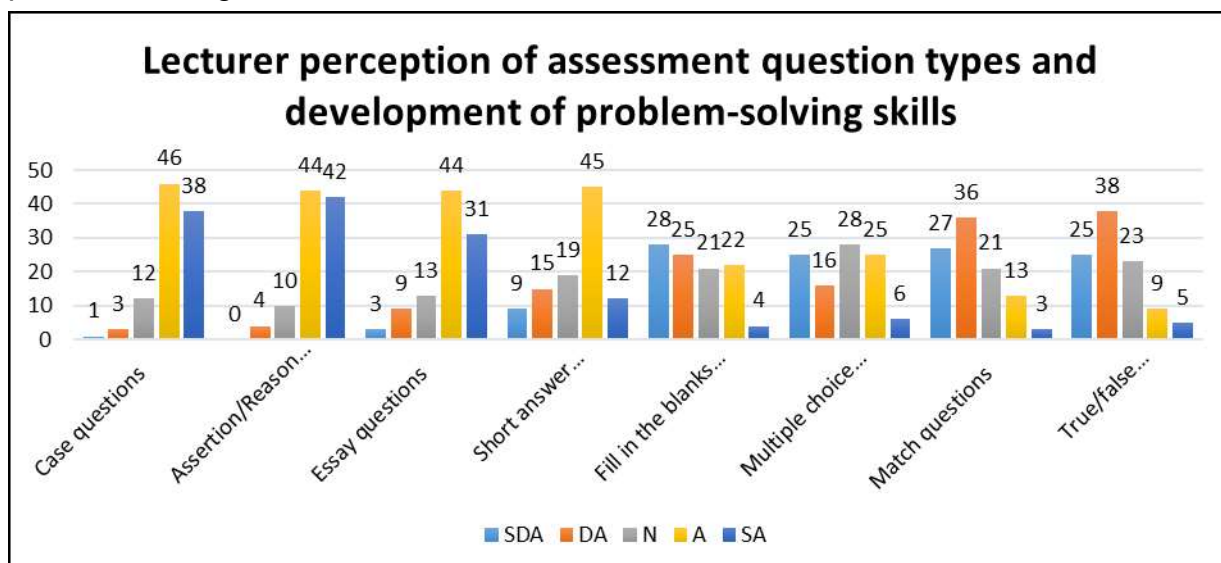

Figure 5: Lecturer perception of assessment question vis-à-vis problem solving skills

It is shown in Figure 5 that most lecturers believed that the following assessment question types can contribute to the development of problem-solving skills in students: case questions (84%), assertion/reasoning (86%), essay (75%), and short answer (57%). It also emerged from the study that lecturers believed that the following assessment question types: fill-in the blanks (26%), multiple choice (31%), matching (16%) and true and false (14%) do not contribute to the development of problem-solving skills in students.

5. Discussion of findings

Results of the study showed that assessments play a significant role in developing problem-solving skills of students. It was further shown in the study that it is not just any type of assessment that can develop problem-solving skills in students but certain types. Such assessments should present students with real-world situations or problems as well as assess and equip them to make appropriate decisions to solve such problems (Astin *et al*. 2016). According to Crebert *et al*. (2011), assessments that develop problem-solving skills in students should be designed based on problem scenarios, group works, work-based problems, committee or enquiry report, a research bid or realistic brief, a case analysis, or a conference paper. Shabani, Khatib and Ebadi (2010) argue that traditional assessment that include true and false, multiple choice, fill-in the gap, and short answer questions fail to evaluate fully matured student abilities as they leave out those abilities which require critical thinking and problem solving. Extant literature shows that assessments that develop problem solving skills do not only develop content knowledge, but go beyond to make students (i) motivated, (ii) obtain a deep under-standing of the content, (iii) learn independently and collaboratively, (iv) obtain higher-order cognitive skills, (v) as well as develop other skills such as critical analysis and communication (Fry, Ketteridge and Marshall 2009; Antonenko, Jahanzad and Greenwood 2014). The above therefore according to SQA (2015) means that choosing appropriate assessment method is crucial to student learning processes and the development of problem-solving skills, and requires professional expertise and knowledge in terms of module content and important skills students should develop.

It emerged in the study that assessment types that include studies written examinations, ICAs, projects, portfolios, short tests, and practical examinations are critical for the development of problem solving skills in students (McCulloch 2007; Ulster University 2016; Sotardi and Brogt 2016). These assessments help develop students' cognitive skills of analysis, synthesis and evaluation, all of which are critical problem-solving skills (SQA 2015). Such assessments help the assessor measure not only the extent of a student's mastery of the content but also the ability to apply that content in novel situations. It was also shown in the study that the following assessment question types: cases, essays, assertion/reasoning, and short answer questions can be used for developing problem-solving skills in students while fill-in the blanks, multiple choice, matching and true and false questions do not promote the development of problem-solving skills in students. These findings confirm results of earlier studies that showed that projects, fieldwork, laboratory work, portfolios, reflective logs, group work/projects, presentations, essays, reports, critical reviews, articles, cases, reaction papers, objective/short answer/practical questions, dissertation, production of a video, magazine, newsletter, exhibition, play, etc. which are all forms of coursework assessment (McCulloch 2007; Ulster University 2016), help develop problem-solving skills in students. Case studies particularly can be utilized to develop problem-solving and decision-making skills as well as improve time management skills (Hains-Wesson 2015; Surgenor 2010).

The study further showed that using assessments to develop problem-solving skills in students comes with a number of challenges. First, such assessments are time-consuming both in terms of preparation and grading (SQA 2015; Surgenor 2010; Hains-Wesson 2015). Other challenges affecting the ability of lecturers and teachers to use assessments that develop

problem-solving skills in students include high workloads, lack of policy guidelines that provide guidance and direction on how to design and implement these types of assessments, lack of training on how assessments develop problem-solving skills as well as lack of supervisory support (Emil 2011; Nunley, Bers and Manning 2011).

Conclusion

Based on the results of the study, it is concluded that some assessment strategies can be used to develop problem-solving skills of students at university level. Such assessments strategies that promote the development of problem-solving skills in students include practical examinations, projects, portfolios, short tests, written examinations, and ICAs, while oral examinations or presentations do not promote the development of problem-solving skills. Further, there are some assessment type questions that can be used to develop problem-solving skills in students; these include case, essay, short answer and assertion/reasoning questions while assessment question types that include multiple choice, fill-in the blanks, matching, and true and false do not promote the development of problem-solving skills in students. In addition, attempts to develop and implement assessments that develop problem-solving skills in students at the university are affected by a number of challenges, particularly a lack of training on how to develop such assessments as well as a lack of lecturer support from immediate and top management.

Results of the current study show that a university needs to address some critical issues to ensure that lecturers are able and willing to design assessment that develop problem-solving skills in students. The first issue to be considered ensuring that all lecturers involved in the running of assessments receive training on how to effectively design assessments. Such knowledge will not only provide the lecturers with both the knowledge and skills required to effectively design the assessments but will motivate them to want to do so. Secondly, rationalizing workloads of staff is very important at the university as high workloads seem to be demoralizing to staff by taking away time for them to plan and design effective assessments. Third, some form of framework is needed at the university to act as a guideline on how assessments that develop problem-solving skills in students can be designed and executed. This study provides an important contribution to the body of knowledge on the development of assessments that develop problem-solving skills in students. Industry is now looking for graduates with problem-solving abilities and hence it is incumbent upon universities to capacitate their lecturers with the ability to develop assessments that provide students with these much needed skills.

References

Antonenko, P., Jahanzad, F. and Greenwood, C. 2014. *Research and Teaching: Fostering Collaborative Problem Solving and 21st Century Skills Using the DEEPER Scaffolding Framework.* Journal of College Science Teaching, [online] Vol 43, Issue 9, pp.79-88.

Astin, A., Banta, T., Cross, K., El-Khawas, E., Ewell, P., Hutchings, P., Marchese, T., McClenney, K., Mentkowski, M., Miller, M., Moran, E. and Wright, B. 2016. *9 Principles of Good Practice for Assessing Student Learning.* Available: *http://www.asbmb.org/ uploadedfiles/education/teachingstrategies/workshop/assessmentall.pdf*, ASBMB-RCN Workshop: Assessment of Students' Reasoning with Core Concepts and Visualizations in Biochemistry. Washington DC. [Accessed 13 May 2018].

Birjandi, P., Estaji, M. and Deyhim, T. 2013. The Impact of Dynamic Assessment on Reading Comprehension and Metacognitive Awareness of Reading Strategy Use in Iranian High School Learners. *Iranian Journal of Language Testing,* Vol 3, Issue 2, 12-19.

Crebert, G., Patrick, C., Cragnolini, V., Smith, C., Worsfold, K. and Webb, F. 2011. *Problem Solving Skills Toolkit. 2nd ed.* Brisbane: Griffith Institute for Higher Education (GIHE).

Creswell, J.W. 2015. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research, 5*th *ed*. Boston, MA: Pearson.

Darling-Hammond, L., Herman, J., Pellegrino, J., Abedi, J., Aber, L., Baker, E., Bennett, R., Gordon, E., Haertel, E., Hakuta, K., Ho, A., Linn, R., Pearson, D., Popham, J., Resnick, L., Schoenfeld, A., Shavelson, R., Shepard, L., Shulman, L. and Steele, C. 2013. *Criteria for High-Quality Assessment.* Stanford: Stanford Center for Opportunity Policy in Education.

Derrell, T. 2015. *5 Common Types of Educational Assessment.*Viewed on 19th January, 2019 from *https://www.aiuniv.edu/blog/2015/july/educational-assessment.*

Emil, S. 2011. *Assessment for Improvement in Higher Education: Faculty Perception of and Participation in Program Assessment*. Dissertations and Theses. Viewed on 7th May , 2018 from *https://pdxscholar.library.pdx.edu/open_access_etds/605.*

Fletcher, R., Meyer, L., Anderson, H., Johnston, P. and Rees, M. 2011. *Faculty and Students Conceptions of Assessment in Higher Education.* Higher Education, Vol 64, Issue 1, pp.119-133.

Fry, H., Ketteridge, S. and Marshall, S. 2009. *A Handbook for Teaching and Learning in Higher Education*. 3rd ed. New York: Routledge.

Hains-Wesson, R. 2015. *Development of the problem solving teaching resource.* Problem Solving. Viewed on 3rd December, 2016 from *http://teachassist.deakin.edu.au/wp-content/ uploads/2015/06/GLO5-problem-solving.pdf*

Hanlon, B. and Larget, B. 2011. Samples and Populations. Case Studies. Madison: Department of Statistics, University of Wisconsin—Madison. Viewed on 1st October, 2016 from *http:// www.stat.wisc.edu/~st571-1/03-samples-4.pdf .*

Harris, L. and Brown, G. 2010. Mixing interview and questionnaire methods: Practical problems in aligning data. *Practical Assessment Research and Evaluation*, Vol15, Issue 1, 2-10.

Higher Education Academy. 2012. A Marked Improvement - Transforming assessment in higher Education,Viewed on 9th November, 2016 from https://www.heacademy.ac.uk/system/files/ a_marked_improvement.pdf.

Kim, K. and Choi, J. 2014. The Relationship between Problem Solving Ability, Professional Self Concept, and Critical Thinking Disposition of Nursing Students. *International Journal of Bio-Science and Bio-Technology*, Vol 6, Issue 5, 131-142.

Lantolf, J. and Poehner, M. 2010. Dynamic assessment in the classroom: Vygotskian praxis for second language development. *Language Teaching Research*, Vol 15, Issue1, pp.11-33.

MacDonald, G. 2014. *Teaching and assessing problem solving skills – PISA recommendations*. Viewed 12th October, 2018 from *http://www.oecd.org/pisa/keyfindings/pisa-2012-results-volume-v.htm.*

Malmeer, E. and Zoghi, M. 2014. Dynamic Assessment of Grammar with Different Age Groups. *Theory and Practice in Language Studies*, Vol 4, Issue 8, pp12-17.

Mathers, N., Fox, N. and Hunn, A. 2009. *Surveys and Questionnaires. The NIHR Research Design Service for Yorkshire & the Humber. Nottingham: National Institute for Health Research.Viewed on 6*[th] *October , 2016 from* https://www.rds-yh.nihr.ac.uk/wp-content/ uploads/2013/05/12_Surveys_and_Questionnaires_Revision_2009.pdf [Accessed 6 October 2016].

McCulloch, M. 2007. *An Introduction to Assessment. Learning and Teaching Centre.* Glasgow: University of Glasgow.

Meng, X. 2013. *Scalable Simple Random Sampling and Stratified Sampling.* In: 30th International Conference on Machine Learning. Georgia: JMLR: W&CP. Viewed on 5th October, 2016 from *http://www.jmlr.org/proceedings/papers/v28/meng13a.pdf*

Mills, K. & Kim, H. 2017. *Teaching problem solving: Let students get 'stuck' and 'unstuck'.* Viewed on 25th October, 2018 from *https://www.brookings.edu/blog/education-plus-development/2017/10/31/teaching-problem-solving-let-students-get-stuck-and-unstuck/.*

Nunley, C., Bers, T. and Manning, T. 2011. *Learning Outcomes Assessment in Community* Colleges. National Institute for Learning Outcomes Assessment. Champaign: *National Institute for Learning Outcomes Assessment (NILOA).* Viewed on 4th December, 2016 from *http://www.learningoutcomesassessment.org/documents/CommunityCollege.pdf*

O'Neill, G. 2011. *A Practitioner's Guide to Choice of Assessment Methods Within a Module.* 1st ed. Dublin: UCD Teaching and Learning.

Organization for Economic Co-operation And Development (OECD), 2014. *PISA 2012 Results:Creative Problem Solving: Students' Skills in Tackling Real-Life Problems.* 1st ed. [online]: PISA, OECD Publishing.Viewed on 4th December , 2016 from *https://www.oecd.org/pisa/keyfindings/PISA-2012-results-volume-V.pdf*

Ozgur, B. and Kantar, M. 2012. *Dynamic Assessment (DA) & Zone of Proximal Development (ZPD).* Viewed on 17th September, 2018 from *www.ealta.eu.org/events/.../ BurcuMurat_EALTA_SIG_ Ankara2012.*

Rahbardar, H., Abbasi, M. and Talaei, A. 2014. *Dynamic Assessment (DA) and Evaluation of Problem-solving Skills in Childeren.* International Journal of Pediatrics. Viewed on 6th December, 2016 from *http://ijp.mums.ac.ir.*

Scottish Qualifications Authority, 2015. Guide to Assessment. Glasgow: SQA.

Shabani, K., Khatib, M. and Ebadi, S. 2010. Vygotsky's Zone of Proximal Development: Instructional Implications and Teachers' Professional Development. *English Language Teaching*, Vol 3, Issue 4, 34-41.

Sotardi, V. and Brogt, E. 2016. *Common student problems with assessment during the transition to university: Support staff perspectives, insights, and recommendations.* 1st ed. Wellington: Ako Aotearoa National Centre for Tertiary Education.

Spiller, D. 2012. *Principles of Assessment. Teaching Development*. Hamilton: The University of Waikato.

Stassen, M. and Doherthy, K. 2001. *Program-Based Review and Assessment - Tools and Techniques for Program Improvement.* Amherst: University of Massachusetts.

Surgenor, P. 2010. *Teaching Toolkit: Summative and Formative Assessment. University College Dublin Teaching and Learning Resources*. Dublin: University College Dublin. Viewed on 1st December, 2016 from *http://www.ucd.ie/t4cms/UCDTLT0029.pdf*

Swartz, R. and McGuinness, C. 2014. *Developing and assessing thinking skills. Literature Review and Evaluation Framework*. Boston & Northern Ireland: The International Baccalaurate Organization.

The Quality Assurance Agency for Higher Education (QAA), 2012. *Understanding assessment: its role in safeguarding academic standards and quality in higher education. 2nd ed.* Gloucester: The Quality Assurance Agency of Higher Education.

Tremblay, K., Lalancette, D. and Roseveare, D. 2012. *Feasibility Study Report Volume 1 – Design and Implementation. Assessment of higher education learning outcomes.* OECD. Viewed on 4th December, 2016 from *http://www.oecd.org/education/skills-beyond-school/ AHELOFSReportVolume1.pdf*

Ulster University, 2016. *Assessment Handbook. Assessment Handbook*. Coleraine: Ulster University.

Zohrabi, M. 2013. *Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. Theory and Practice in Language Studies.* Viewed on 3rd October, 2016 from *http://www.academypublication.com/issues/past/tpls/vol03/02/06.pdf.*