THE RESEARCH CYCLE: APPLIED

AN EVALUATION OF STUDENT PERCEPTIONS OF TEACHING AND LEARNING STRATEGIES IMPLEMENTED WITHIN THE GALWAY-MAYO INSTITUTE OF TECHNOLOGY 'IDENTIFICATION SKILLS FOR BIOLOGISTS' MODULE

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ABSTRACT

The Identification Skills for Biologists (ID Skills) module aims to enhance the identification skills of students and raise their awareness of taxonomy. Student-centred learning (SCL) is key to the successful completion of the module however; it remains unclear whether students feel it is an appropriate teaching and learning (T&L) approach for developing new taxonomic skills. The aim of the current research is to assess the perception of students regarding T&L and assessment strategies implemented within the diatom taxonomic group. Three objectives were defined 1) To assess student perceptions of T&L and new skills gained, 2) To examine the effectiveness of the assessment strategy aligned to meet the learning outcomes, and 3) To evaluate student-centered recommendations on T&L and assessment strategies. These objectives were examined using mixed methods research, both quantitative and qualitative data collection, analysis and interpretation. Due to time constraints and the small-scale nature of the research, the perception of students studying other taxonomic groups (e.g. caddisflies, amphipods) was not pursued. Key findings indicate that while students see SCL as an integral part of the learning for this module, the workload far exceeded that expected of a five-credit module. Key skills gained by students were expertise using compound and inverted microscopes, and creating temporary slides. These essential taxonomic skills where perceived as important by the students particularly in gaining employment in the future. Student-centered recommendations on T&L and assessment strategies that will benefit the design of the module include revising the workload and timelines to allow for better time management and equality among topics offered, introducing an online blog/forum for students to share information, and introducing weekly spot tests to improve ongoing knowledge. This research article proceeds by introducing the most relevant literature in student-centered pedagogy, research methodologies, research findings and discussion, and wraps up with key conclusions and recommendations.

KEYWORDS: Student-centered learning, Mixed research methods, Questionnaires, Focus groups

INTRODUCTION

The Identification Skills for Biologists module (hereafter referred to as ID Skills) takes place in semester 2 of third year on the BSc Applied Freshwater and Marine Biology degree in Galway-Mayo Institute of Technology (GMIT). The module aims to increase the identifcation skills of students and raise their awareness of the tools and resources needed to advance this skill within a specialist taxonomic group of their choice (Nash, Gammell, Lennon, & Lally, 2015, p. 2). The teaching and learning (T&L) strategy combines lectures and practicals with student-directed learning alongside formative and summative assessment forming 100% continuous assessment (Nash et al., 2015, p. 2). Student-centred learning (SCL) is key to the successful completion of the module however, as this module is still in its infancy, it remains unclear whether students feel it is an appropriate T&L pedagogy for developing new taxonomic skills.

The aim of the current research is to assess the perception of students regarding T&L and assessment strategies implemented within the diatom group of the module ID Skills. To achieve the aim three objectives were defined 1) To assess student perceptions of T&L and new skills gained throughout the module, 2) To examine the effectiveness of the assessment strategy employed to meet the learning outcomes of the module, and 3) To evaluate student-centered recommendations on T&L and assessment strategies which will benefit the design of the module ID Skills in the future.

Combining quantitative and qualitative data analysis (mixed methods research) provides a better understanding of how students perceive the T&L and assessment strategies implemented within the diatom group of the module ID Skills. Due to time constraints and the small-scale nature of the research, the perception of students studying other taxonomic groups (e.g. caddisflies, amphipods) within the ID Skills module was not pursued.

This research article proceeds by introducing the most relevant and up-to-date literature in student-centered pedagogy and associated T&L and assessment approaches and is followed, in turn, by research methodologies, research findings and discussion, and wraps up with key conclusions and recommendations.

LITERATURE REVIEW

This section presents theoretical perspectives behind the philosophy of student-centered pedagogy and examines student-centered teaching and learning, and assessment strategies used in science at third level institutions.

Student-centered learning (SCL) is a widely used term in higher education across the world. In Ireland, the introduction of The Bologna Declaration (1999), a European policy to reform higher education to make it more transparent and comparable, was followed by a review of the Irish third level education sector (DES, 2011, p. 43), and mutually resulted in student-centered pedagogy becoming a leading learning approach (Attard, Di Ioio, Geven, & Santa, 2010, p. 6). Student-centered pedagogy refers to the implementation of teaching methods that allow students to develop their own knowledge and skills by doing activities that are facilitated by the lecturer (Harden & Crosby, 2000, p. 335; O'Neill & McMahon, 2005, p. 28). Student-centered learning (SCL), therefore, is based on constructivist pedagogy. The origin of constructivism comes from Piagetian theory (Piaget, 1979 in Connell, Donovan, & Chambers, 2016, p.3; Piaget, 1952 in Mascolo, 2009, p. 3). Constructivism refers to knowledge and skills learned by students over time where they incorporate new ideas into existing knowledge and understanding formed from shared, participatory interactions with their peers during active learning (Kain 2002, p. 104; Piaget, 1979 in Connell et al. 2016, p. 3). Mascolo (2009, p. 4) highlights that constructivism "involves the transformation of existing knowledge into increasingly higher-order forms" of thinking where "new knowledge develops out of existing knowledge". Therefore, SCL pedagogy and the philosophical meaning of constructivism both place emphasis on providing the student with the opportunity to develop their own learning and knowledge by "actively doing and/or experiencing" (Attard et al., 2010, p. 9-10; Harden & Crosby, 2000, p. 335; Mascolo, 2009, p. 2; Singh, 2011, p. 276). For third level science students, this means taking personal responsibility for their own learning (McCabe & O'Connor, 2014, p. 350). This shift in teaching focus from lectures to class activities and lecturer to students corresponds with a move from teaching to learning (Attard et al., 2010, p. 6). This pedagogical shift promotes independent learning, critical thinking, problem-solving, increases motivation to learn, greater retention of knowledge, deeper understanding of the topic, and positive attitude towards the topic (Armbruster, Patel, Johnson, & Weiss, 2009, p.

203; McCabe & O'Connor 2014, p. 355; Singh, 2011, p. 276). It also requires the lecturer to become a facilitator providing expertise and advice, engaging students with their current knowledge and introducing creative activities that transform and elevate their future knowledge and skills (Mascolo, 2009, p. 2-5; McCabe & O'Connor, 2014, p. 351).

Teaching and learning (T&L) strategies that encourage SCL ideologies and constructivism are important if students are to benefit fully from their own learning. Singh (2011, p. 276) lists a number of popular SCL activities that can easily be substituted for lectures such as: active learning experiences e.g. quizzes, case studies, assigning open-ended problems requiring critical thinking, and self- and/or team- learning e.g. role play, group discussions, debates. The UCD Centre for Teaching and Learning (2005) recommends simply stating the learning outcomes at the beginning of a module/lecture, focusing the student to consider "what they will be able to do" in terms of skills, knowledge and understanding on completion of the module/lecture rather than what content will be covered by the lecturer. Learning outcomes emphasise to students what competencies and transferable skills they should be developing; motivating them to be active in acquiring their own knowledge. The use of just-in-time teaching where the lecturer tailors lectures to address student questions and misconceptions highlighted in discussion groups (Connell et al. 2016, p. 12) is effective in creating clarity around difficult topics. This method also provides opportunity for other students to reflect on their own learning and provides an opportunity to re-evaluate, synthesise and communicate their learning and knowledge on a topic.

Student-centered pedagogy has resulted in an increase in formative assessment strategies. Formative assessments, for example reflective diaries, portfolios, quizzes, peer/self-assessment and group work all encourage SCL pedagogy. Such assessments result in better monitoring of student progress throughout a module by the lecturer and student, allowing for a steady increase in knowledge, skills and learning over time (Costine, Marron, & Costine, 2012, p. 128). From the lecturers perspective, formative assessments provide ongoing, clear feedback (e.g. written comments on reports) on the current learning of the student and identifies gaps for future development (O'Neill & McMahon, 2005, p.31). Formative feedback should promote the development of thoughts, acknowledge the students ongoing progress,

encourage hard work and further development, and identify future steps necessary to attain the required understanding, knowledge and skills (Mascolo, 2009, p. 19). Connell et al. (2016, p. 12) has shown that systematic formative feedback improved the learning of science students in third level education. In addition, this offered the lecturer the opportunity to modify assessment instructions in response to student mis-understanding (Connell et al., 2016, p. 2). Thus, formative feedback can promote learning for both the student and lecturer.

SCL has been shown to be an effective T&L and assessment pedagogy for science in third level institutions in Ireland (O'Neill & McMahon, 2005, p.33). However, there is still some debate regarding when best to implement such pedagogical strategies in third level higher education. McCabe & O'Connor (2014, p. 352) suggest implementing SCL pedagogy in first year as students expect a significant change in teaching style and format between secondary and third level education. However, the literature suggests that SCL approaches are more prevalent in the latter years of university (third and fourth years). This could be due to a combination of smaller class sizes, better understanding of SCL methods by students and a willingness by students to embrace SCL methods (O'Neill & McMahon, 2005, p. 33). The long-lasting benefits of SCL pedagogy extend beyond that of the lecture room and equips students with lifelong learning skills in future employment (Attard et al., 2010, p. 14; Mascolo, 2009, p. 8; O'Neill & McMahon, 2005, p.30). Notwithstanding the benefits, several challenges remain with the implementation of SCL approaches. These include: the capacity of lecturers to prepare suitable active learning activities to meet the different learning styles, abilities of student groups, clashing timetables, reluctance of students due to lack of confidence and motivation, and many students are not sufficiently prepared academically for higher education (Blackie, Case, & Jawitz, 2010; McCabe & O'Connor, 2014, p. 356; Kain, 2002, p. 105). In facing these challenges, the literature evidence suggests that small changes towards the implementation of SCL pedagogy can lead to improved academic performance in science topics in third level education (Connell et al., 2016, p. 2, 13).

This section introduced the theoretical perspectives behind the philosophy of student-centered pedagogy implemented in third level institutions with specific reference to teaching and learning, and assessment approaches used in science.

The next section considers the theoretical perspectives behind the philosophy of mixed methods research and examines the mixed methods research methodologies applied within the context of the current research.

RESEARCH METHODOLOGIES

MIXED METHODS RESEARCH: THEORETICAL PERSPECTIVES

This section presents theoretical perspectives behind the philosophy of mixed methods research allowing for clearer interpretation and understanding of social science research. In addition, this places core ideas on mixed methods research and pragmatism in the context of up-to-date published research. Specific attention will be given to the use of questionnaires, focus groups and assessment marks.

There are varying definitions of mixed methods research used (Johnson, Onwuegbuzie, & Turner, 2007, p. 119-121). For the purposes of this study, mixed methods research encompasses both qualitative and quantitative research approaches in the collection, analysis and interpretation of data (Creswell & Plano Clark, 2011, p. 2-6; Feilzer, 2010, p. 8; Gorard, 2012, p. 5; Teddlie & Tashakkori, 2012, p. 777). This integration of qualitative and quantitative approaches at all levels of the research should be obvious and complementary resulting in datasets that yield more meaning and are richer in information than if the methods were considered individually (Feilzer, 2010, p. 12; Onwuegbuzie, Bustamante, Nelson, 2010, p. 72; Woolley, 2009, p. 8). This approach to mixed methods research is what actually defines the methods as mixed. Key benefits of using both qualitative and quantitative research approaches include uncovering a wider range of information and validating the data collected, which in turn, increases there reliability and the accuracy of conclusions (Denscombe, 2008, p. 272; Reams & Twale, 2008, p. 133).

The application of constructivism philosophy, as defined in the literature review above, aligns with the philosophical understanding of mixed methods research. Taking a constructivist approach to mixed methods research allows the researcher to view reality as revisable (ontology) and encourages participants to voice their opinions resulting in multiple perspectives (Creswell & Plano Clark, 2011, p. 41) (Table 1). These multiple perspectives are then investigated forming key themes that

can be further researched. Therefore, allowing for a deductive approach to the interpretation of mixed methods research (Creswell & Plano Clark, 2011, p. 41-43) (Table 1).

Table 1. Constructivism placed within the assumptions for determining the philosophy of social science (Adapted from Creswell & Plano Clark, 2011, p. 42).

Elements of Philosophy	Meaning	Constructivism
Ontology	What is the nature of reality?	Multiple realities
Epistemology	How is knowledge acquired?	Closeness
Axiology	What is the role of values in research?	Biased
Methodology	What methods are most appropriate?	Deductive

In reality, mixed methods researchers struggle to incorporate and integrate fully philosophical perspectives of social science and the demands of understanding and interpreting quantitative and qualitative data together. This is especially true in the beginning as researchers apply a known paradigm based on personal and/or previous bias which involves investigating data, findings and conclusions separately (Bryman, 2007, p. 8; Feilzer, 2010, p. 9). Researchers also have a tendency to use post-positivism (researcher's background, knowledge and values can influence data) and constructivism paradigms to quantitative and qualitative data respectively (Creswell & Plano Clark, 2011, p. 40) and/or there can be confusion between what actually qualifies as a qualitative or quantitative approach (Woolley, 2009, p. 7-8). Creswell & Plano Clark (2011, p. 45) indicate that more than one philosophical approach can apply to mixed methods research and that it should be encouraged to ensure accurate interpretation of quantitative and qualitative data in mixed methods research.

In an effort to help transition between differing paradigms and validate the mixed methods research approach, methodological triangulation can be employed. Triangulation, as defined by Cohen et al. (2011, p. 195), is "the use of two or more methods of data collection in the study of some aspect of human behaviour". In essence, using both quantitative and qualitative data collection methods to enhance

understanding of the data collected. For the purposes of this study, three data collection methods were triangulated: questionnaires (quantitative and qualitative), focus groups (qualitative) and assessment results (quantitative).

Questionnaires are a commonly used quantitative and qualitative data collection method that lends itself to statistical analysis (Cohen et al., 2011, p. 256, 382). Key benefits include: questions are focused, quick to code, participants can be compared, and it is a quick method of capturing perceptions to specific situations and changes in circumstances (Bailey, 1994, p. 118; Kumar, 2005, p. 130-132; Oppenheim, 1992, p. 115). By far the biggest limitation is low sampling return possibly due to poor questionnaire design and wording (Cohen et al. 2011, p. 261; Kumar, 2005, p. 130). Additionally, information provided may be irrelevant and/or redundant which can make it difficult to draw comparisons across students (Cohen et al., 2011, p. 382).

Focus groups are a group interview where participants have the freedom to interact and make recommendations based on their combined reactions and experiences (Cohen et al., 2011, p. 436; Morgan, 1988, p. 9). Key benefits of focus groups include the opportunity to gather data from multiple individuals on their attitudes, values and opinions allowing for greater coverage of topics. In addition, to providing a safe and comfortable platform in which students can make personal comments and recommendations (Bailey, 1994, p. 192-193; Krueger, 1988; Morgan, 1988; Philips, 2003, p. 84; Robson, 2002, p. 284-284). However, to avoid comment pitfalls it is important that all students are clear about the agenda and should stay focused on the questions posed. The moderator must choose the correct venue and prompt thinking and reflection from students (Newby, 2010, p. 350-351).

Assessment results can be used as a substitute measure of knowledge and skills gained thereby indicating to what extent the learning outcomes of the module have been met. They, additionally, give an indication of how well the module was designed and the effectiveness of each assessment in meeting the learning outcomes (Philips & Stone, 2000, p. 95; Costine et al., 2012, p. 127). Performance based formative and summative assessments are applicable when gauging practical skills such as diatom identification while written summative assessments are useful

in assessing theory (Costine et al., 2012, p. 128-129; Philips, 2003, p. 78-79; Philips and Stone, 2000, p. 96, 104).

This section introduced mixed methods research methodology and the underlying philosophy for interpreting mixed methods research through constructivism. This philosophical standing allows the researcher to incorporate multiple perspectives in identifying key themes in the data. The triangulation of quantitative and qualitative methods results in a complementary, integrated approach to all aspects of the research allowing for a deeper and richer understanding of the key research findings and conclusions.

The next section considers the application of mixed methods research methodologies applied within the context of the current research.

MIXED METHODS RESEARCH: APPLICATION WITHIN THIS STUDY

This section presents the mixed methods research methodologies applied within the context of the current research. A detailed description of the questionnaires and assessments is provided along with a thorough account of how the focus group was planned and executed.

Pre- and post- questionnaires were applied as both a quantitative and qualitative method to assess student perceptions of T&L and new skills gained throughout the module ID Skills (Objective 1). Pre- and post- questionnaires provided a simply way of determining whether or not students perceived a difference in T&L and level of skill gained before and after completion of the module ID Skills (Philips & Stone, 2000, p. 86). The pre- and post- questionnaires posed 16 and 13 questions respectively that were structured and closed-ended using the Likert Scale; an attitude ranking system which ranged from 1 to 5 (strongly agree to strongly disagree) (Cohen et al., 2011, p. 382, 387, 390; Garavan, Hogan, & Cahir-O'Donnell, 2003, p. 510-514; Kumar, 2005, p. 132). In addition, four unstructured, open-ended questions were presented on both the pre- and post- questionnaire to gather feedback on student experiences (Garavan et al., 2003, p. 510). Pre- and post-questionnaires were self-administered in the presence of the researcher.

Ten students, six males and four females, chose to study diatoms as part of their ID Skills module. Prior to students completing the pre-questionnaire, the research project aims and objectives were explained and all participating students gave consent (by signing a consent form). At all times the anonymity of the students was ensured as student names were coded.

The pre-questionnaire was issued to participating students on 16th January 2017. Seven of the ten participating students completed the pre-questionnaire. One student left class early to attend work and two other students were on fieldwork. Follow-up pre-questionnaires were issued however, completed forms were not returned. The post-questionnaire was issued on 17th February 2017. Nine participating students completed the post-questionnaire; one student subsequently withdrew from the module. Therefore, six pre- and post- questionnaires (total n = 12) were analysed for the purpose of the study. Quantitative data was transcribed into MS Excel and subsequently imported to IBM SPSS (version 24) for statistical analysis. Wilcoxon signed rank tests (ordinal, related, non-parametric) (Cohen et al., 2011, p. 655-661) were conducted to compare teaching and learning and skills gained before and after the completion of the module ID Skills.

The focus group, a qualitative data collection method, evaluated student-centered recommendations on T&L and assessment strategies from participating students that will benefit the design of the module ID Skills (Objective 3). All ten participating students attended the focus group on Friday 19th February 2017. The focus group questions were composed of eight structured, open-ended questions under three themes: teaching, learning and skills, and assessment strategies (n=24) with three questions posed under other comments (n=3). The researcher facilitated the focus group with answers recorded during the session. The focus group was also recorded with the permission of the participating students to ensure data was recorded and interpreted correctly. Qualitative data generated from the focus group was transcribed into MS Excel where interpretation of data commenced. The data was grouped under themes: teaching, learning and skills, assessment strategies and other comments separately and key trends in responses identified.

On completion of the module ID Skills, continuous assessment marks were used to examine the effectiveness of the assessment strategy in meeting the learning

outcomes of the module (Objective 2). Five assignments assessed the taxonomic skills and knowledge gained in diatom identification as part of the module ID Skills. These included 8 test species slide (5%), diatom decision tree (15%), spot test (5%), final practical exam (40%) and a diatom portfolio (35%). Nine out of ten participating students (n=9) successfully completed the module ID Skills. Descriptive statistics (mean, median and standard deviation) (Cohen et al., 2011, p. 622-623) were calculated to investigate trends within the datasets. Friedman's ANOVA test (ratio, related, non-parametric, one observation) with Wilcoxon signed rank test, acting as a post hoc test, with Bonferroni correction investigating whether participating students differed in performance across the five assignments and also which assignments had a better overall performance (Cohen et al., 2011, p. 657-660; Dytham, 2011, p. 138, 146; Field, 2005, p. 557-565). Separately, Wilcoxon signed rank test (Cohen et al., 2011, p. 657-658) was applied to examine whether the performance of participating students was a result of gender. All statistical analysis was conducted using IBM SPSS (version 24).

This section considered the mixed methods research applied in the current research project specifically the use of questionnaires as both a quantitative and qualitative data collection method, focus groups as a qualitative data collection method and continuous assessment marks as a quantitative data collection method.

The next section presents the key findings and discussion of the current research.

KEY RESEARCH FINDINGS AND DISCUSSION

This section presents the key research findings from the quantitative and qualitative data gathered using a mixed methods research methodology.

ASSESSMENT OF STUDENT PERCEPTIONS OF TEACHING & LEARNING AND NEW SKILLS GAINED THROUGHOUT THE MODULE

The pre- and post- questionnaires captured qualitative data on the reasons behind participating student's selection of diatoms for their ID Skills module which included: specimens are pretty and interesting (participants 2, 5 & 6), to gain experience in

identifying microscopic organisms (participants 3 & 5) and diatoms was the only topic offered that did not involve dissections (participants 1 & 2). Others wanted to work in the same group as their friends (participants 2 & 7). Overall, reasons for participants choosing diatoms remained the same before and after the five-week module.

Through the analysis of pre- and post- questionnaires and focus group comments, it was clear that students generally enjoyed (participants 2, 5, 6 & 7) and were happy with the teaching they received throughout the five weeks of the module. In addition, their expectations and perceptions of how the module would be delivered to meet the learning outcomes (Q2), the up-skilling opportunities provided by the module (Q4), and lecturer teaching style (Q5 & 6) were the same before and after the module (Table 2).

During the focus group, students indicated that 2hrs of lectures was insufficient time to introduce the topic of diatom identifcation and suggest doubling lecture times (min 4hrs) to allow for the inclusion of lectures on terminology in Europe and United States and key distinguishing features of similar families and genus. Additionally, they felt that the 15 hrs allocated to the lecturer for help and advice with identification of specimens was applied inaccurately. Students would prefer if the allocation of the 15 hrs support time was more flexible to accommodate their questions and need for help with identification of difficult species particularly at the end of the module. While this occurred due to a timetabling conflict the feedback is noted for consideration.

Participating students felt student centered learning (SCL) was an appropriate teaching model to employ for ID Skills. Students enjoyed the fact that they had their own time to complete the tasks set out. Despite this, responses from both the questionnaires and focus group highlighted that they were not happy about having to spend so much of their own time identifying diatoms. This was supported by statistical analysis of Q7 in the pre- (median = 3) and post- (Mdn = 1.5) questionnaire where all six participating students felt sufficient time was not allocated to diatom identification before and after the completion of the module ID Skills (T = 0.00; p = 0.026) (Table 2). The lecturer had indicated a minimum of 4hrs per day as a target to ensure successful completion of 110hrs of self-directed learning on the five-credit module. In fact, many students indicated they had spent more than twice that time (8-10hrs) per day identifying diatoms. This resulted in many students exceeding

200hrs of self-directed learning over the course of the module; a time allocation more reflective of a ten-credit module. This was a much greater drain on time resources than anticipated by both participating students and the lecturer and will be addressed.

Table 2. Perceptions of participating students (n=12) to teaching & learning strategies and skills gained before and after the completion of the diatom section in the ID Skills module. *T* = test statistic for Wilcoxon signed rank test and *p*-value indicates the level of significance. Values in bold are significant.

Teaching and Learning	***T***	***p*-value**
Q1 The learning objectives of the module were clearly defined	3.50	0.577
Q2 The lecture information on this topic was relevant	4.00	0.713
Q3 The assessment schedule was organised and easy to follow	1.50	0.052
Q4 The training will be useful in the future	2.00	0.257
Q5 The lecturer is knowledgeable about the topic diatoms	4.00	0.705
Q6 The lecturer was well prepared	6.00	0.339
Q7 The time allocated to complete the module was sufficient	**0.00**	**0.026**
Q8 The laboratory space and equipment allocated for this module was sufficient	1.50	0.056
Skills		
Q11 How confident are you at identifying diatoms	0.00	0.059
Q12 How proficient are you using a compound microscope	**0.00**	**0.038**
Q13 How proficient are you using a inverted microscope	**0.00**	**0.020**
Q14 How competent are you at preparing temporary mounted slides	**0.00**	**0.027**
Q15 How familiar are you at compiling assessment portfolios	0.00	0.066

Overall participants felt they had gained many new skills and had the opportunity to improve recently acquired ones. Both questionnaires and the focus group captured positive changes in skills gained by participating students. All six students felt and were significantly more proficient using the compound microscope (Q12) (T = 0.00; p = 0.038), inverted microscope (Q13) (T = 0.00; p = 0.020) and in preparing temporary mounted slides (Q14) (T = 0.00; p = 0.027) before and after the completion of the module ID Skills (Table 2). Using identification keys and developing the ability to identify diatom specimens to genus level without an identification guide were additional skills highlighted during the focus group. Nine out of ten students felt that the skills they gained would be useful in obtaining future employment as a freshwater and marine scientist. Albeit, only two of the nine students would choose diatom identification again, if given the choice. Their

motivations were a career in phycology/plankton/phytoplankton. Five participants would have chosen caddisflies with three students choosing amphipods predominantly because their peers studying these groups were perceived to have a much-reduced workload.

THE EFFECTIVENESS OF THE ASSESSMENT STRATEGY EMPLOYED TO MEET THE LEARNING OUTCOMES OF THE MODULE

In general, participating students were content with the assessments allocated over the course of the module. This was reflected in the continuous assessment final marks where all participants passed the diatom section of the module ID Skills. Median assessment marks for the nine students ranged from 44 to 78% with no significant differences observed in the overall median percentage marks between the nine students ($\chi^2(8) = 15.037$, $p = 0.058$)(Figure 1). Median assessment marks for the five assignments ranged from 36 to 74% with seven of the nine students receiving less than 40% in assignment 3 (spot test) (Figure 2). Significant differences in final median percentage marks were observed between the five assignments ($\chi^2(4) = 13.475$, $p = 0.009$) however post hoc tests proved inconclusive following the application of a *p*-value of 0.005 (Bonferroni correction). Further exploration of the dataset highlighted assignment three as an outlier for four students (participants 1, 2, 3 & 7) who received lower than expected marks (27, 39, 36 and 14% respectively) (Figure 3). During the focus group, students indicated that they felt the spot test contained unexpected terms and terminology that they had not revised and were unaware they needed to know. However, similar issues arose three weeks later in the final exam theory irrespective of efforts by the lecturer to remind students to study lecture notes.

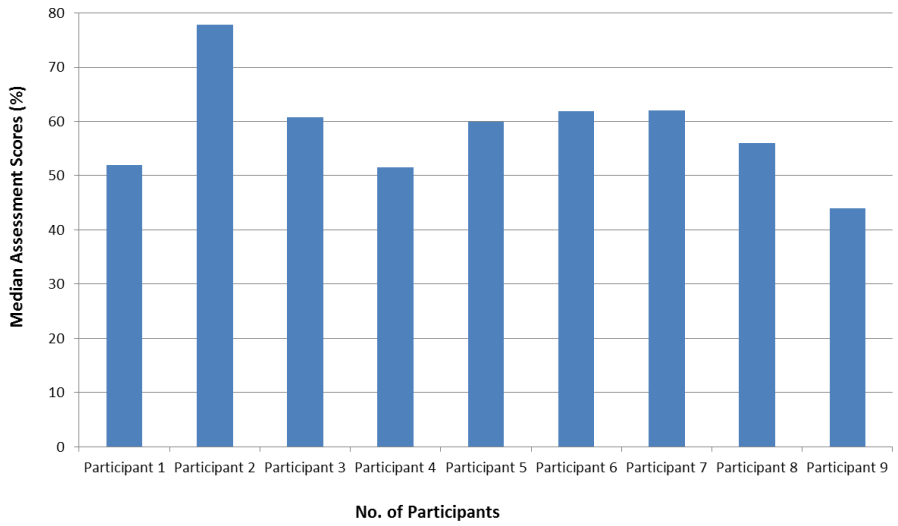

Figure 1. Final median continuous assessment marks observed for the nine participants following completion of the ID Skills module.

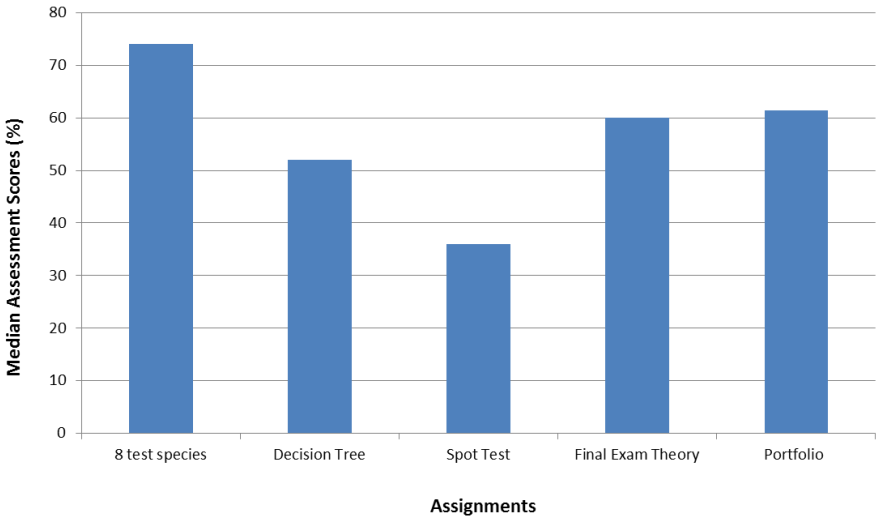

Figure 2. Overall median assessment marks per assignment.

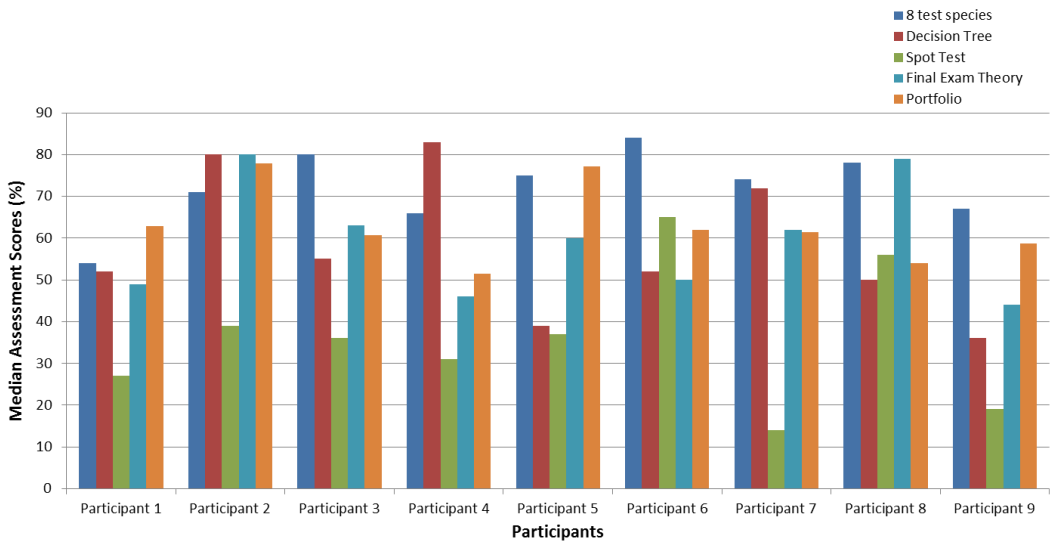

Figure 3. Median continuous assessment marks per assignment for the nine participating students.

Overall, female students (n=3) performed better than male students (n=6). Male students started the module well and showed significantly higher marks in assignment 1 (8 test slide) and 2 (decision tree) (T = 0, p = 0.008 and T = 0, p = 0.008 respectively). Females, on the other hand, showed significantly higher marks for assignment 3 (spot test), 4 (final exam theory) and 5 (portfolio) (T = 0, p = 0.008 respectively) possibly reflecting a higher level of engagement with self-directed learning (SDL) and an increased amount of time sitting and identifying diatoms (Figure 4).

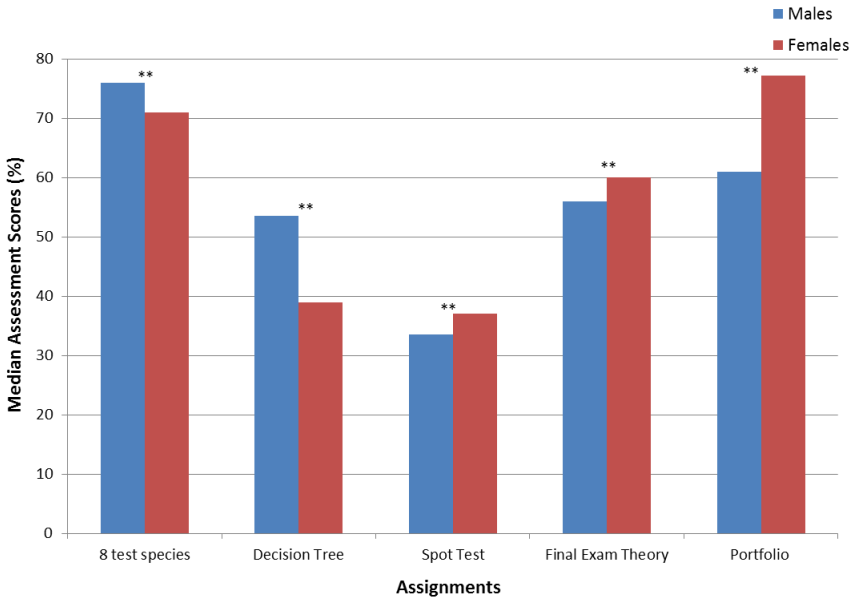

Figure 4. Median continuous assessment marks observed for male and female participants across the five assignments. **denotes significant p-values of <0.01.

STUDENT-CENTRED FEEDBACK ON THE DIATOM SECTION OF THE MODULE ID SKILLS

Upon completion of diatom identification, both questionnaires and focus group data suggested becoming familiar with different types of diatoms and learning to identify them to genus level without the need for a key (participants 2, 5, 6 & 7) were enjoyable aspects of the module. In addition, students enjoyed the freedom associated with self-directed learning. Conversely, aspects of the module students least enjoyed included the greater workload compared to other topics on offer (participants 5, 6 & 7), conducting counts and calculations of diatoms (participants 1 & 2), and using dirty and/or malfunctioning microscopes (participants 2 & 3). The

focus group additionally highlighted student's feelings of inequality compared to their peers who studied other topics and feel the topics offered in the future should have an equal workload for all students. The focus group also raised concerns by some students who worried that too many marks were allocated to the end of the module (75%) making it difficult to know how they were progressing with their overall continuous assessment marks. The final theory exam (40%) and the diatom portfolios (35%) were both due at the end of the module but as the module is so short it would be difficult to reallocate these to other times within the module.

This section considered the key research findings following qualitative and quantitative data collection methods namely understanding why the students selected diatoms, their perceptions of teaching and learning and skills gained throughout the module, and their likes and dislikes.

The final section makes concluding comments and recommendations.

CONCLUSIONS & RECOMMENDATIONS

This mixed methods research aimed to assess the perception of students regarding teaching & learning (T&L), and assessment strategies implemented within the diatom section of the module ID Skills. Through the combined use of qualitative and quantitative data collection methods and a mixed method approach to interpreting the results, it is clear that, in general, participating students enjoyed the module, were happy with the teaching and learning, and assessment strategies employed, and gained significant advancements in their taxonomy skills-set. In saying this, issues were also recognised most notably the heavy workload and associated time constraints of the five week module.

Student perceptions of T&L and new skills gained throughout the module were very positive (Objective 1). Key findings relating to T&L indicated that 2 hrs of lectures and 15 hrs of support time from the lecturer was not sufficient for students to gain confidence in diatom taxonomy, terminology and identification skills. Moreover, while students viewed student-centered learning as an integral part of the learning on this module it was clear that the workload far exceeded that expected of a five-credit module. This heavy workload was a key factor in only two students choosing diatom

identifcation if given the choice again. Key skills gained by students were expertise using compound and inverted microscopes, and creating temporary slides. These essential taxonomic skills where perceived as important by the students particularly in gaining employment in the area of freshwater and marine science.

Participating students performed well across the five assessments demonstrating the assessment strategy employed to meet the learning outcomes of the module was effective (Objective 2). The use of a spot test half way through the module caught many students off guard concerning content and information required however, this did make them reflect on how much actual learning they had achieved. Following the spot test, student put in a concerted effort to improve their diatom identification skills. This may have contributed to the increase in time and workload experienced by students studying diatoms.

Participating students made several important student-centered recommendations on T&L and assessment strategies that will benefit the design of the diatom section of the module ID Skills in the future (Objective 3). Key improvements to T&L and assessment strategies, recommended by students included:

- Revising the workload and timelines to allow for better time management and equality among topics offered,
- Increasing lecture times (minimum of 4hrs),
- Allowing more flexibility around the application of practical support time (15hrs),
- Introducing an online blog/forum to allow students to share their information on terms, terminology, photos, and difficult specimens,
- Introducing weekly spot tests to improve ongoing knowledge of diatoms,
- Providing clearer instructions on the requirements of the portfolio and,
- Providing better alignment of staff and student expectations.

Participating students also offered some recommendations on identification topics they would like to see introduced to the module ID Skills which included: dolphin, whale and shark photographic ID, fish otoliths and dissections, microplastics ID and characterisation, and polychaete ID. Personal traits students felt important were patience and good time management skills as these are key to taxonomic work.

Finally, students strongly suggested that topics offered in ID Skills should be of an equal workload and fair to all students.

The most important area the lecturer needs to address is the perceived heavy workload in comparison to other topics on offer. The lecturer proposes a reduction in SCL assessments to three such as weekly spot tests (20%), eportfolio (50%) and final exam theory (30%). Over four weeks offer weekly spot tests to ensure students have grasped the required terminology to aid diatom identification and that they are successful in correctly identifying specimens to genus and species level. The application of an eportfolio will allow students to add specimens to their species list daily including photos and text. The lecturer will issue clear and concise instructions on what is required in the eportfolio and this should reduce the workload at the end of the module and make it easier for the lecturer to check their ongoing progress. The final exam theory will remain to ensure students can navigate identification keys and correctly identify diatom specimens on their own merit. In an effort to allow for better student understanding of diatom taxonomy and key terms two additional lectures will be added dealing with terminology used within the European and American identifcation keys and distinguishing features of similar families and genus. The lecturer will also try to be more flexible in the allocation of practical support time but recognises this may be difficult depending on timetabling of other modules.

Overall, it is expected that the implementation of these student-centered recommendations will allow for improvements within the diatom section of the module ID Skills and will allow for the alignment of staff and student expectations that are perceived fair to all.

LIST OF REFERENCES

Armbruster, P., Patel, M., Johnson, E., & Weiss, M. (2009). Active Learning and Student-Centered Pedagogy Improve Student Attitudes and Performance in Introductory Biology. *CBE Life Sciences Education*, *8*, 203-213. doi:10.1187/cbe.09-03-0025

Attard, A., Di Ioio, E., Geven, K, & Santa, R. (2010). *Student Centered Learning. An Insight into Theory and Practice*. Bucharest: Partos Timisoara.

Bailey, K. D. (1994). *Methods of Social Research* (4th ed.). New York: The Free Press.

Blackie, M. A. L., Case, J. M., & Jawitz, J. (2010). "Student Centredness: The Link Between Transforming Students and Transforming Ourselves". *Teaching in Higher Education, 15*(6), 637-646.

Bryman, A. (2007). Barriers to Integrating Quantitative and Qualitative Research. *Journal of Mixed Methods Research*, *1*, 8-22. doi:10.1177/2345678906290531

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7th ed.). Routledge, UK.

Connell, G. L., Donovan, D. A., & Chambers, T. G. (2016). Increasing the Use of Student-Centered Pedagogies from Moderate to High Improves Student Learning and Attitudes about Biology. *CBE Life Science Education*, *15*, 1-15. doi:10.1187/cbe.15-03-0062

Costine, P., Marron, S., & Costine, J. (2012). *Professional Practice in Training and Development: An Essential Guide*. Kildare, Ireland: Irish Institute of Training and Development.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). USA: SAGE.

Denscombe, M. (2008). Communities of Practice: A Research Paradigm for the Mixed Methods Approach. *Journal of Mixed Methods Research*, *2*(3), 270-283. doi: 10.1177/1558689808316807

Department of Education and Skills (DES), (2011). *National Strategy for Higher Education to 2030*. Report of the Strategy Group. Dublin: DES.

Dytham, C. (2011). *Choosing and Using Statistics: A Biologists Guide* (3rd ed.). UK: Wiley-Blackwell.

Field, A. (2005). *Discovering Statistics Using SPSS* (2nd ed.). UK: SAGE.

Feilzer, M. Y. (2010). Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods Research*, *4*(1), 6–16. doi: 10.1177/1558689809349691

Garavan, T. N., Hogan, C., & Cahir-O'Donnell, A. (2003). *Making Training & Development Work: A Best Practice Guide*. Cork, Ireland: Oak Tree Press.

Gorard, S. (2012). Mixed Methods Research in Education: Some Challenges and Possibilities. In The Research Council of Norway (eds). *Mixed Methods in Educational Research*. Report from the March Seminar, Oslo.

Harden, R. M., & Crosby, J. (2000). Amee Guide No. 20: The Good Teacher is More Than a Lecturer-The Twelve Roles of the Teacher. *Medical Teacher*, *22*(4), 255-275. doi: 146 6-187/00/04033.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Towards a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, *1*(2), 112-133. doi:10.1177/1558689806298224

Kain, D. K. (2002). Teacher-Centered verus Student-Centered: Balancing Constraints and Theory in the Composition Classroom. *Pedagogy*, *3*, 104-108.

Kumar, R. (2005). *Research Methodology: A Step-by-step Guide for Beginners* (2nd ed.). SAGE: London.

Krueger, R. A. (1988). *Focus Groups: A Practical Guide for Applied Research*. Beverly Hills, CA: Sage

Mascolo, M. F. (2009). Beyond Student-Centered and Teacher-Centered Pedagogy: Teaching and Learning as Guided Participation. *Pedagogy and the Human Sciences*, *1*(1), 1-25.

McCabe, A., & O'Connor, U. (2014). Student-Centered Learning: The Role and Responsibilities of the Lecturer. *Teaching in Higher Education, 19*(4), 350-359. Doi:10.1080/13562517.2013.860111

Morgan, D. L. (1988). *Focus Groups as Qualitative Research*. Beverly Hills, CA: Sage.

Nash, R., Gammell, M., Lennon, S., & Lally, H. (2015). *Module Documentation for Identification Skills for Biologists* (BIOL07022). Academic Module Manage for Galway Mayo Institute of Technology.

Newby, P. (2010). *Research Methods in Education*. Harlow, UK: Pearson Education.

Onwuegbuzie, A. J., Bustamante, R. M., & Nelson, J. A. (2010). Mixed Research as a Tool for Developing Quantitative Instruments. *Journal of Mixed Methods Research*, *4*(1) 56–78. doi:10.1177/1558689809355805

Oppenheim, A .N. (1992). *Questionnaire design, interviewing and attitude measurement*. London: Heinemann.

O'Neill, G., & McMahon, T. (2005). Student-Centered Learning: What Does It Mean For Students and Lecturers? In: G. O'Neill, G. Moore & B. McMullin (Eds.), *Emerging Issues in the Practice of University Learning and Teaching*. Dublin: AISHE.
Philips, J. J. (2003). *Return on Investment in Training and Performance Improvement Programs* (2nd ed.). USA: Butterwort-Heinemann.
Philips, J. J. & Stone, R. D. (2000). *How to Measure Training Results. A Practical Guide to Tracking The Six Key Indicators*. USA: McGraw-Hill.
Reams, P., & Twale, D. (2008). The Promise of Mixed Methods: Discovering Conflicting Realities in the Data. *International Journal of Research and Methods in Education*, *31*(2), 133-142. doi: 10.1080/17437270802124509
Robson, C. (2002). *Real World Research* (2nd ed.). Oxford: Blackwell.
Singh, N. (2011). Student-centered Learning (SCL) in Classrooms – A Comprehensive Review. *Educational Quest*, *2*(2), 275-282.
Teddlie, C., & Tashakkori, A. (2012). Common "Core" Characteristics of Mixed Methods Research: A Review of Critical Issues and Call for Greater Convergence. *American Behavioural Scientist*, *56*(6) 774–788. Doi:10.1177/0002764211433795
The Bologna Process (1999). *The European Higher Education Area*. Bologna: Bologna Process.
UCD Centre for Teaching and Learning, (2005). *Module Design and Enhancement Overview*. Retrieved from http://www.ucd.ie/teaching/resources/moduledesignenhancement/
Woolley, C. M. (2009). Meeting the Mixed Methods Challenge of Integration in a Sociological Study of Structure and Agency. *Journal of Mixed Methods Research*, *3*(1), 7-25. Doi: 10.1177/1558689808325774