International Conference NEW PERSPECTIVES in SCIENCE EDUCATION

The Effect of the Implementation of a Variety of Inquiry Based Pedagogical Strategies on Student Learning in Science, with a Focus on Students from Disadvantaged (Deis) Schools

Samantha Prior[1], Audrey O' Grady[2]

Abstract

As students' interests in secondary school science are dramatically decreasing, teachers are faced with the dilemma of trying to engage their students in class. However, it is even harder to engage students in Science from one of the 192 schools promoting the Delivering Equality of Opportunity in Schools (DEIS) initiative in Ireland. The DEIS action plan was created to ensure educational inclusion and to overcome educational disadvantage throughout Ireland. Despite this apparent prioritisation of the educational needs of young people from disadvantaged communities, the uptake of Science subjects in disadvantaged schools remains significantly lower than the national average. It is important to address the gap between Science up take by students from disadvantaged communities. Often students from these communities are influenced by the 'norm', and as a result have little to entice them to pursue what is considered to be a more challenging subject.

Innovative teaching methods can be seen as the answer to this problem and thus improving student learning and engagement in Science. The purpose of this study is to review the literature extensively, and identify which pedagogical strategies work best to actively engage students from disadvantaged schools in Science. Innovative pedagogical methods such as inquiry based science education, problem based learning, hands on learning, peer learning and the use of advanced technologies are examined in great detail, with the focus of the review being on identifying and summarising the core features of a lesson that allow students from disadvantaged schools to learn best in Science, and thus encouraging the students to have a voice in their own education - this enables them to contextualise their own learning in a creative, hands-on engaging way. Research has shown that the use of innovative pedagogical strategies can have a dramatic effect on student learning and engagement. There is an overwhelming difference in student attitudes towards Science, and thus their uptake of the subject in the upper tier of secondary school, and at third level because of the successful implementation of innovative teaching methods in Science.

1. Introduction

The start of secondary school can be a difficult time for most students. It is noted that students from lower socio-economic backgrounds are more likely to feel this strain and face difficulties when transitioning from primary school to secondary school, especially when learning new subjects [1]. Students from disadvantaged backgrounds tend to struggle to see the relevance of these new subjects in their everyday lives. There is a direct link between economic capital and educational advantage, something that discourages students from disadvantaged backgrounds from taking up subjects that are not seen to be useful in the workforce [2]. Therefore, it is not a surprise that students from disadvantaged communities are less likely to take up science subjects in secondary school. Most issues occur in science because students cannot conceptualise new ideas and cannot see the relevance of science in their own lives, therefore the new concepts are just memorised and rewritten for the exams [3]. It is the purpose of this literature review to identify strategies to improve learning in science with a particular focus on students from disadvantaged DEIS schools.

[1] University of Limerick, Ireland
[2] University of Limerick, Ireland

2. Pedagogical Strategies

2.1 Scientific inquiry in the classroom

Scientific inquiry is defined as a learning strategy that allows students to develop and process knowledge, while also increasing their interest and motivation in science [4]. The use of scientific inquiry is proven to be an effective teaching strategy that can be implemented to engage students in a science classroom [5]. The purpose of scientific inquiry in a classroom is to encourage students to think in ways that are similar to how scientists think. It is essential that students acquire the skills associated with scientific inquiry to encourage them to test their own hypotheses, and carry out investigations to discover new abstract ideas that they may not have associated with science [6]. Only when these skills have been acquired can students fully develop their understanding of key ideas and theories in science. Studies [5,6, 7] have shown that the more emphasis put on scientific inquiry and hands on activities in the classroom encourages students to develop a deeper understanding and appreciation for scientific subjects. However, there are several issues attached to the implementation of scientific inquiry in the classroom, teachers focus too much on obtaining the correct answers to questions, and don't allow students' scientific inquiry skills to fully develop [8]. There is also a presumption attached to students who do try using their newly acquired skills and ask many questions, the presumption that they are misbehaving or causing trouble for the teacher. This is something that is seen in many science classrooms in disadvantaged communities, and can be disheartening for these students, and unfortunately can discourage them from having a voice in their own science learning. It is essential that this practice is dissolved overtime, and science educators make note that science learning is stimulated by inquiry, as it allows the construction of new knowledge and understanding. Inquiry-based learning also allows the development of expertise in critical thinking and intellectual growth, all of which are essential components of any science classroom [9].

2.2 Use of active learning in the classroom

It was Dewey (1936) who first investigated the idea of active learning, and he created the learning by doing model that has been advocated by schools so much in recent years [10]. Science educators are being encouraged to use and adapt active learning into their science classrooms. The differences in student learning and understanding of science have been noted as the main advantages of using active learning consistently [11]. Others [12] have also advocated the use of active learning, and suggest that the advantage of its use is that learning can be converted from a routine process into a personalised process for students, in which critical thinking and problem solving skills are developed. Other advantages noted are science classes becoming student centered as opposed to teacher centered, the development of social skills through continuous interactions with classmates, and most importantly, active learning encourages the amalgamation of both theory and practice, something that is essential for learning in science. It has been highlighted that active learning can massively increase student performance in science, and can benefit them more than most other learning strategies [13]. Increased participation and practice in science is something that can help students from disadvantaged DEIS schools who are struggling to grasp key ideas in science, as it allows them to develop the educational tools required to increase their conceptual understanding of science. However, it is important to note that active learning is something that students do, not something that is done on them [14]. Visual simulations, problem based learning, scenarios and co-operative learning are all methods that can be easily incorporated into the science classroom, to fully promote and enhance the active learning experience for students [15]. The idea of active learning being advantageous to the classroom is emphasised, and it is noted that students who actively engage in science recognise and understand scientific knowledge more than those who do not [7].

2.3 Problem Based Learning and ICT

Problem Based Learning (PBL) was first developed to highlight the relevance of a subject to the real life context through the use of problems [16,17]. This learning strategy can be used in many subjects and has a significant effect on learning when it is used in science [16]. One of the main purposes of PBL is to develop students' autonomy, and allow them to be in control of their own learning. Studies have shown that the use of PBL has increased student learning and motivation in science [16,17]. PBL would be an excellent addition to the science classroom, as it allows students to see how science is applicable to their own lives. However, it could also be argued that the use of PBL assumes that students from disadvantaged DEIS schools are already motivated in science beforehand.

It is also highlighted that ICT and the use of digital teaching materials are valuable teaching and learning tools, and are an excellent addition to any classroom. Difficult topics such as osmosis and cell division can be enhanced by the use of technologies. In cell division, differences and similarities between cells were easily explained using visual simulations which were shown to improve student learning in science over conventional methods. It is noted that ICT was shown to help students who are visual learners and struggled to conceptualise the key theories taught in science [18]. Both PBL and ICT have both been shown to increase student learning in science, however discrepancies were noted with the direct instruction and delivery given by different science educators.

3. Conclusion

It can be concluded that scientific inquiry, active learning, problem based learning and the use of advanced technologies improve student learning and motivation in science, especially with students from disadvantaged DEIS schools. Each of these strategies can easily be added to the science classroom, and are not dependent on economic capital [2]. These basic elements can encourage students to interact in a hands on engaging manner, and allows students to apply their new knowledge and further develop their learning and inquiry process in science [19].

References

[1] Morgan, Y., Sinatra, R., and Eschenauer, R. (2015) A Comprehensive Partnership Approach Increasing High School Graduation Rates and College Enrollment of Urban Economically Disadvantaged Youth [online], Education and Urban Society 47(5), available: doi: 10.1177/0013124514536437

[2] Wagner, V.C., Veenestra, C.P, Orr, M.K., Ramirez, N.M., Ohland, M.W., and Long, R.A. (2014) Gaining Access or Losing Ground? Socioeconomically Disadvantaged Students in Undergraduate Engineering 1994 – 2003, The Journal of Higher Education, 85(3), 339 – 369

[3] Topocu, M.S., and Sahin-Pekmez, E. (2009) Turkish Middle School Students' Difficulties in Learning Genetic Concepts, Turkish Journal of Science Education, 6(2), 55 – 6

[4] Avsec, S., & Kocijancic, S. (2016). A Path Model of Effective Technology-Intensive Inquiry-Based Learning. Educational Technology & Society, 19 (1), 308–320

[5] Germann, P.J., Haskins, S., and Auls, S. (1996) Analysis of Nine High School Biology Laboratory Manuals Promoting Scientific Inquiry, Journal of Research in Science Teaching, 33(5), 475 – 499

[6] Wolf, M., and Laferriere, A. (2009) Crawl into Inquiry-Based Learning [online], Science Activities Classroom Projects and Curriculum Ideas, 46(3), available: doi: 10.3200/SATS.46.3.32-38

[7] Taraban, R., Box, C., Myers, R., Pollard, R., and Bowen, C.W. (2007) Effects of Active-Learning on Achievement, Attitudes and Behaviours in High School Biology, Journal of Research in Science Teaching 44 (7), 960 – 979

[8] Bencze, L. and Hodson, D. (1999) Changing Practice by Changing Practice: Toward More Authentic Science and Science Curriculum Development, Journal of Research in Science Teaching, 36(5), 521 - 539

[9] Spronken-Smith, R., and Walker, W. (2010) Can inquiry based learning strengthen the links between teaching and disciplinary research [online], Studies in Higher Education, 35(6), available: doi: 10.1080/03075070903315502
[10] Dewey, J. (1936) Experience and Education, New York: Kappa Delta Pi
[11] Allen, D., and Tanner, K. (2005) Infusing Active Learning into the Large-enrolment Biology Class: Seven Strategies, from the Simple to Complex, Cell Biology Education, 4(1), 262 – 268
[12] Akınoğlu, O., and Tandoğan R.O. (2007) T*he Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning,* Eurasia Journal of Mathematics, Science & Technology, 3(1), 71 – 81
[13] Freeman, S., O'Connor, E., Parks, J.W., Cunningham, M., Hurley, D., Haak, D. Dirks, C. and Wenderoth, M.P. (2007) Prescribed Active Learning Increases Performance in Introductory Biology, CBE Life Sciences Education, Summer 2007, 132 - 139
[14] Anderson, R.D. (2002) Reforming Science Teaching: What Research says about Inquiry, Journal of Science Teacher Education, 13 (1), 1 - 12
[15] Bonwell C.C., and Eison, J.A. (1992) *Active Learning: Creating Excitement in the Classroom,* Washington D.C.: The George Washington University School of Education and Human Development
[16] Wijnia, L, *, Loyens, S., van Gog, T., Derous, E., and Schmidt,H.G. (2014), Is there a role for direct instruction in problem-based learning?, Elsevier, 34(2014), 22-31
[17] Allen, D. and Tanner, K. (2003) Approaches to Cell Biology Teaching: Learning Content in Context—Problem-Based Learning, Cell Biology Education, 2(1), 73–81,
[18] Yang (2015) Yang, K.T., Wang, T.H., and Chiu, M.H. (2015) Study the Effectiveness of Technology-Enhanced Interactive Teaching Environment on Student Learning of Junior High School Biology, Eurasia Journal of Mathematics, Science & Technology Education, 2015, 11(2), 263-275
[19] Sivan, A., Wong Leung, R., Woon, C. & Kember, D. (2000) An Implementation of Active Learning and its Effect on the Quality of Student Learning [online], Innovations in Education & Training International, 37(4), available: doi: 10.1080/135580000750052991