Student Perceptions of Using Blended Learning in Secondary Science

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Abstract
Australian school student participation in senior science subjects has declined over the last 20 years. A recent report from the Office of the Chief Scientist (2014) discussed the pedagogical approach of Australian science teachers as an area of concern. As *blended learning* is one pedagogical approach to improved student engagement, this study investigated student perceptions on the use of a blended learning approach when teaching the Australian Year 10 Earth Science curriculum. Blended learning integrates online teaching and face-to-face (classroom) teaching. The study was conducted with two Year 10 Science classes at an independent, state school in Far North Queensland, Australia. Online components were available to students using the learning management system Blackboard® as it is the preferred system supported by the state education system in Queensland.

This paper reports on a mixed methods analysis comprising both quantitative and qualitative data sources to describe aspects of blended learning the Year 10 students perceived as barriers and benefits. The study also investigated students' motivation for using eLearning within a blended learning pedagogy and opportunities for improved student engagement. This study contributes to our understanding of factors affecting students' engagement in secondary science, and the results illuminate some of the key aspects of a successful blended learning approach to teaching science.

Keywords: blended learning, pedagogies, secondary science, Australian Curriculum, Earth Science, student engagement, web-based learning

Introduction

Several studies link the decline in post-compulsory science education in Australian secondary schools to a decline in student engagement with science in the junior secondary school (i.e. students aged 12-16) (Ainley, Kos, & Nicholas, 2008; Goodrum, Druhan, & Abbs, 2012; Lyons & Quinn, 2010; Office of the Chief Scientist, 2012). Researchers have proposed a number of measures to address declining engagement and enrolment in secondary science (Ainley et al., 2008; Goodrum et al., 2012; Lyons & Quinn, 2010; Tytler, Osborne, Williams, Tytler, & Clark, 2008). These recommendations can be summarized as: (1) improved curriculum content; (2) improved teacher quality and expertise; and (3) enhanced focus and flexibility of enacted science pedagogies.

Australian Federal Government reforms to develop a national science curriculum and implement coherent professional standards for teachers address the first two recommendations. The new Australian Curriculum for Science in 2012 addressed gaps in the curriculum, specifically the inclusion of the *Science as a Human Endeavour* strand, which connects science learning to everyday life (ACARA, 2013). The Australian Government addressed national teacher quality by establishing the Australian Institute for Teaching and School Leadership (AITSL) in 2010, and introducing policies such as the *Smarter Schools National Partnership for Teacher Quality* (AITSL, 2015). While both policies include statements on the use of Information and Communication Technology (ICT), guidance on a specific pedagogical approach to ICT integration is not included. Our research seeks to understand approaches that junior secondary science teachers can use to embed ICT to improve the flexibility of their pedagogy.

Using technology in science teaching has many benefits (Guzey & Roehrig, 2012; Hayes, 2007; Lee & Tsai, 2013). Online learning has been shown to improve student attitudes and achievement in secondary science (Chandra & Watters, 2012; Lee, Linn, Varma, & Liu, 2010; Sun & Looi, 2013); create opportunities for collaborative learning (Rosen & Nelson, 2008); and increase student engagement as a critical step to improving science pedagogy (Lyons & Quinn, 2010). For Chandra and Watters (2012), the success of online learning is linked to facilitating individual coaching, scaffolding, modelling, and more effective questioning. However, research also shows computer use is not always well integrated into classroom teaching and learning (Donnelly, McGarr, & O'Reilly, 2011; Goodrum et al., 2012; Hayes, 2007; Webb, 2013). In their report on *The Status and Quality of Year 11 and 12 Science in Australian Schools*, Goodrum et al. (2012) found the transmission model for teaching science still prevails, and 73% of science students still spend a significant amount of their time copying notes from the teacher. Also, students reported they had little choice in pursuing areas of interest, and that practical work tended to be 'recipe based' with students asked to follow a set of instructions rather than embarking on true inquiry.

Blended learning is one successful approach to integrating technology, including mobile technologies, into standard classrooms (Moskal, Dziuban, & Hartman, 2013). For the purposes of this study, blended learning is defined as a pedagogical approach that explicitly integrates online and face-to-face learning, and where students have meaningful interactions with their teacher with and without the mediation of electronic technology (Waha & Davis, 2014). Blended learning can provide a more personalized and student-centred learning experience while still allowing students to readily access teacher support (Boulton, 2008; Staker & Horn, 2012). However, the challenge of blended learning is to create well-designed and organized content that maintains students' motivation and strengthens their time management skills (Barbour, 2008).

Quasi-experimental comparisons of traditional and blended learning favour a blended learning approach in secondary science (Chandra & Briskey, 2012; Chandra & Watters, 2012; Yapici & Akbayin, 2012). Although the majority of published research has been conducted within university settings, similar studies within secondary school mathematics and science classrooms indicate promising directions for higher student achievement and engagement (Chandra & Briskey, 2012; Chandra & Watters, 2012; Yapici & Akbayin, 2012). A case study on the effects of blended learning within four year 9 Turkish biology classes, where two classes received non-blended teaching, and two classes received online blended learning, showed increased achievements for students in the blended learning classes compared to those taught using the standard method (Yapici & Akbayin, 2012). Chandra and Watters (2012) conducted a study with Year 10 physics students to find blended learning had a positive impact on student's attitudes towards studying physics. Chandra and Briskey (2012) compared pedagogies in secondary school mathematics and showed that students participating in blended learning performed better and were more engaged. However, a blended learning approach is not equally engaging for all students and may be influenced by preferred learning style (Chandra & Briskey, 2012). Other studies investigating the use of a blended learning approach in different secondary subjects reported similar improvements in student achievement (Psycharis, Chalatxoglidis, & Kalogiannakis, 2013; Wan & Nicholas, 2010).

The initial successes led researchers to further explore the effect of different models of blended learning. Cheung and Hew (2011) investigated two models in a university setting. The first model was based on the GNOSIS framework to "integrate constructive and didactic instruction approaches"(Cheung & Hew, 2011, p. 1321). Their second model was based Blooms taxonomy (remembering, understanding, applying, analysing, evaluating, and creating). This research allowed useful insights into theoretical constructs supportive of blended learning, however these models were very labour intensive, reducing the potential for a high level of uptake in classrooms. Chen (2012) investigated two simplified models with primary school students, online plus peer interaction, and online plus student-teacher interaction. While noting improved student achievement overall, there was no significant difference between the two models of blended learning. In terms of the optimal balance of online versus face-to-face instruction, we found only one study that dealt with this matter. Chou, Chuang, and Zheng (2013) researched varying ratios of face-to-face to online teaching, and found that a time ratio of 2:1 was optimal. Effective blended learning must incorporate a robust pedagogical framework, a well-developed web interface, combined with an appropriate balance of online time versus face-to-face instruction and it is clear that further research is needed.

There is consensus that, when designed in conjunction with good teaching practices, blended learning can contribute to improved student achievements and engagement (Calderon, Ginsberg, & Ciabocchi, 2012; Chandra & Briskey, 2012; Chandra &

Fisher, 2009; Chandra & Watters, 2012; López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011; Pina, 2012; Yapici & Akbayin, 2012). Improving student engagement is a key factor in improving enrolments and achievement in secondary school science.

Methodology

The aim of this study was to investigate student perceptions of a blended learning approach to teaching secondary science. To achieve this, our primary research questions were: What aspects of blended learning are important to students? What are students' attitudes towards blended learning? What aspects of online learning do students prefer? How does blended learning influence student engagement in secondary science? This study adopted a descriptive case study methodology to investigate these questions. The study was conducted in a suburban state high school (Grades 8-12), pseudo-named FNQ High School. FNQ High School is located in a culturally diverse community in Far North Queensland in a city with a population of approximately 157,000 residents. During the study, 891 students were enrolled at FNQ High School, 48% females and 52% males, with 10% of the student population identifying as Aboriginal or Torres Strait Islander and 10% of students indicating they had a language background other than English.

Two Year 10 science classes from FNQ State High School participated in this study. Year 10 science is a compulsory subject, and students are assigned to classes based on their results from Year 9 science. There were 52 participating students, 35% female and 65% male, aged 15 and 16 years. The study was conducted over one, ten-week school term during which students studied a unit on Earth and Space Science from the Australian Curriculum. A blended learning approach was designed for this study. Students accessed online content and activities using the Blackboard® learning management system available through Education Queensland's Learning Place.

The GRR Pedagogical Approach Explained

Lyons and Quinn (2010) argue engaging and inclusive science teaching is more valued by students. Carter et al. (2012) found that students perform well in learning situations that promote competence, engender autonomy, and encourage relatedness. One pedagogical model that incorporates these criteria and provides balance between Direct and Inquiry-based teaching is the *Gradual Release of Responsibility* (GRR) model (Fischer & Frey, 2003; Fisher & Frey, 2008).

The GRR model has its origins in research on meaningful cognitive processing by Rosenshine (1995), who described three key instructional implications from his research: "(a) the need to help students develop background knowledge (b) the importance of student processing (engender autonomy), and (c) the importance of organizers" (p.262). These principles are incorporated in the GRR model for teaching (Maynes, Julien-Schultz, & Dunn, 2010). Using the GRR model, new information is presented and learned in three phases: firstly, the teacher explains new information, the *I Do* stage; secondly, the teacher works with students through guided practice, the *We Do* stage; and thirdly, the students gradually work towards independence, the *You Do* stage. The first two phases of the GRR model are clearly Direct Instruction techniques, however, the last phase presents opportunities for incorporating inquiry-learning principles, enabling students to construct their own understanding.

The theoretical foundation for the *I Do* phase of the GRR model is based on Vygotsky's Zone of Proximal Development - the difference between what a child may learn on their own and what they can learn with guidance, including scaffolding (Wood, Bruner, & Ross, 1976). Scaffolding is a teaching strategy to stimulate a "child's interest in the task, establishing and maintaining an orientation towards task-relevant goals, highlighting critical features of the task that the child might overlook, demonstrating how to achieve goals, and helping to control frustration" (Wood & Wood, 1996, p. 5). Maynes et al. (2010) identify the *I Do* phase as motivation, modelling/ remodelling, and structured consolidation. The *I Do* phase is the opportunity for teachers to explicitly set out learning goals and explain key ideas and concepts.

In the *We Do* phase of the GRR model, teachers provide guided instruction to establish expectations and provide support for students to meet those expectations (Fisher & Frey, 2008). This phase of the GRR model emerges from Piaget's work on cognitive structures and schema. Piaget emphasized listening to children, "valuing their stage of learning and thinking and ensuring learning activities are developmentally appropriate" (Groundwater-Smith, Le Cornu, & Ewing, 1998, p. 80). More recent developments of cognitive learning theory are that, as people learn, new information is organised and stored, allowing the learner to more readily access the knowledge when required (Groundwater-Smith et al., 1998). Well-connected and elaborate knowledge structures enable easier retrieval of old material, allows more information to be carried in a single chunk, and facilitates integration of new information (Rosenshine, 1995). The supported practice of the *We Do* phase assists students in developing familiar pathways and improving their ability to access this information at a later date.

According to Fisher and Frey (2008) the *You Do* phase of the GRR model is better divided into two sub-phases, *You do it together*, and *You do it alone* where students have the opportunity to apply new knowledge to a new situation. In a science classroom, this means student-centred inquiry learning, such as an individual or group designed experimental investigation. The *You Do* phase is founded on Social Learning Theory (Bandura, 1977) and more recent work on personal constructivist approaches that emphasize the importance of internal reflection in the learning process. The *We Do* phase emerges from a social constructivist perspective, emphasising the importance of the social context and collaboration between peers in developing a deeper understanding. The *You Do* phase focuses the active role of the learner in building understanding and can provide an opportunity for students to construct their knowledge independently and in collaboration with peers.

A goal of any science curriculum is to develop students' scientific inquiry skills, as well as science understandings (ACARA, 2013). One of the key aspects of science education is teaching student how to pose questions and use evidence to draw valid conclusions. To achieve this, many science teachers implement some form of an Inquiry-Based teaching pedagogy. Research by Tytler, Haslam, Prain, and Hubber (2009) showed the benefits of explicitly teaching some aspects of the science curriculum, while also providing means for students to undertake inquiry learning. The GRR model is a viable approach to teaching science inclusive of both direct and inquiry-based instruction. The GRR was chosen as the pedagogical approach for this study.

The researchers modified the Year 10 Earth and Space Science program based on the Australian Curriculum (ACARA, 2013) according to the GRR model. The unit was covered in 10 weeks with three, 70 minute lessons per week. Each lesson followed the GRR model where students received a teacher directed consolidation of the previous lesson, followed by a short explanation of the key topics for the lesson (*I Do*). Students then accessed online learning materials through the subject website which they worked through in small groups with teacher assistance (*We Do*), or individually (*You Do).* Online learning materials were developed in Blackboard®, and included video clips, reading comprehension exercises, interactive learning objects, discussion board tasks, and a short quiz at the end of each lesson.

Data Collection

Student perceptions of online learning were investigated using a written survey and focus group interviews. The Web-based Learning Environment Instrument (WEBLEI) (Chandra, 2004; Chang & Fisher, 2003) was chosen to gather perception data. The Web-based Learning Environment Instrument (WEBLEI) was developed by Chang and Fisher (2003) to gather quantitative data about undergraduate and graduate students perceptions of web-based learning environments. Chandra (2004) modified the WEBLEI for use in a secondary classroom setting. The WEBLEI contains four scales, Access, Interaction, Response and Results. The WEBLEI has eight questions for each of the four scales, where participants respond using a Likert scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree). The first three scales are based on the work of Tobin (1998), and aim to describe students perceptions of emancipatory activities, co-participatory activities, and qualia (e.g. interest, curiosity, enjoyment, satisfaction) in an online learning environment. The fourth scale, results, focuses on the structure and delivery of the online material. Ten short response questions were also included in the WEBLEI to give student the opportunity to more clearly articulate their perceptions. Students completed the WEBLEI questionnaire at the conclusion of the course, once they had completed all assessment and received their results. The data from the Likert scale questions were converted to numerical values: strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, strongly disagree = 1. Descriptive statistics including mean, mode and standard deviation were calculated using SPSS 22. The Cronbach's alpha was also calculated to measure the internal consistency of each of the four WEBLEI scales

Focus group interviews were conducted to further investigate student experiences of participating in blended learning. Focus group interviews were conducted two weeks after students had completed the unit. Two, 45 minute group interview sessions were conducted with 5 students from each class. The interviews were semi-structured with all participants given an opportunity to respond and comment. The interviews were recorded, transcribed and then coded in NVIVO using the four WEBLEI scales Access, Interaction, Response and Results.

Results and Discussion

The results are presented using the four scales from the WEBLEI questionnaire, Access, Interaction, Response and Results. A total of 52 students participated in this study, 29 students completed the WEBLEI questionnaire, and 10 students participated in the focus group interviews. Overall, the Gradual Release of Responsibility model proved appropriate in this context for developing a blended learning approach in two Year 10 secondary science classrooms.

Reliability

Cronbach alpha reliability coefficients were calculated to measure the internal consistency of each of the four WEBLEI scales. The accepted cut-off for Cronbach's alpha in social science research is .70 or higher (Rovai, Baker, & Ponton, 2013). Cronbach's alphas for the four scales Access, Interaction, Response and Results were .89, .68, .80 and .91, respectively. Although the reliability of the Interaction scale is slightly below the cut off, the results of the scale can be considered relevant, and some research has advocated a lower cut-off of 0.60 (Chandra, 2004; Chang & Fisher, 2003).

Student Perceptions

The mean and standard deviation for each scale of the WEBLEI are presented in Table 1. The results were highest for the Access scale (M = 3.86, SD=0.74), and lowest for the Response scale (M=3.36, SD=0.65).

Table 1: Mean and Standard Deviations for the Four scales for student responses to the WEBLEI

WEBLEI Scales	Descriptive Statistics			Cronbach's Alpha
	N	Mean	Standard Deviation	
ACCESS	29	3.86	0.74	0.89
INTERACTION	29	3.55	0.54	0.68
RESPONSE	29	3.36	0.65	0.80
RESULTS	29	3.64	0.73	0.91

The Access scale measured students' perceptions of emancipatory activities within the blended learning environment. Overall, the mean for the Access scale was the highest of the four scales, (M=3.86, SD=0.74), and indicates students perceived the online learning environment provided convenient, accessible, independent and flexible learning opportunities. Students were particularly positive about the accessibility of the lessons and the ability to access work outside of class times, with 90% of participants agreeing that the lessons on the internet were available at locations suitable for them. This was further supported by data from focus group interviews.

> Heather (pseudonym): It teaches a more independent way of learning and it's good for kids that have been away, they can catch up on the work from the day.

> Brenda (pseudonym): You can learn at your own pace, prioritise specific things to learn, catch up at home on missed lessons, revise other passed lessons, and access online text-books.

Fifty-two per cent (52%) of students agreed blended learning allowed them more opportunity to explore their own areas of interest.

> Terry (pseudonym): I feel like I learned more then what I would have if I had just done it with the teacher in the class, because I was able to branch off of the things that interested me and that I wanted to learn.

The Interaction scale measured students' perceptions of co-participatory activities. A mean of 3.55 (SD = 0.54) for the Interaction scale suggested a small amount of agreement with the items in this scale. However, a more detailed analyses of the results showed this mean is strongly influenced by Question 9, "I communicate with my teacher in this subject electronically via email", where the mode of students responses was 'disagree'. By contrast, the mode of student's responses to Question 11, "I have the option to ask my teacher what I do not understand by sending an email", was 'agree'. The mode response to Question 12, "I feel comfortable asking my teacher questions via email", was 'agree'. While students agreed that they could send an email to their teacher, the majority did not choose to do so.

Focus group data also indicate a preference for more direct teacher interaction and instruction.

> Terry (pseudonym): It's better having a teacher up at the front teaching you and going over the stuff instead of having each lesson [online] to do.

> Wendy (pseudonym): I feel like a whole lesson with the teacher is interactive. You get to ask questions and you get to have class discussions about it. I feel like that's interactive enough, we don't need a computer and then specific interactive activities, I feel like I would prefer just the teacher.

However, there was some indication that students' unfamiliarity with online learning was an important factor in this study.

> Karen (pseudonym): I do think [maturity] is a pretty big factor because this is the first time we've really had this much independence with something online … and I think in order for [online learning] to work you would need to introduce it probably in year 6 or 7, in primary schools, so you got used to it throughout, because it will be something in university and probably senior schooling as well that we will need to get used to and being independent is pretty important."

The third scale, Response, measured students' perceptions of qualia such as enjoyment and confidence. The majority of students, 62% indicated they learned more with blended learning and 55% indicated they enjoyed learning in this modality. The mean result for the WEBLEI Response scale was 3.36 (SD= 0.65, Table 1) - the lowest mean of the four scales. Year 10 students had varied opinions of the blended learning approach in terms of their expressed satisfaction, interest and enjoyment.

Questions 17, 21, and 22 investigated student perceptions of their ability to work with other students in the class, and Questions 18, 19, 20, 23 and 24 investigated student enjoyment and interest. A majority of students generally enjoyed learning with using a blended learning approach as 55% of respondents agreed or strongly agreed, 31% neither agreed nor disagreed, and 14% disagreed or strongly disagreed. The novelty of blended learning may have played a role. And some students do prefer a teacher-centered approach and directed instruction. The comments show a mixed response.

> Robert (pseudonym): Some people find (online) learning easier, but others find internet learning a lot more complicated and it can get confusing, so those people fall behind.
>
> Tim (pseudonym): eLearn didn't really improve my results in science because it is hard to focus when you are just using the internet. I learn better when a teacher is telling me what to do.
>
> Karen (pseudonym): I believe it is a good idea with plenty of potential. Easier access and ability to search for alternate resources.
>
> Ben (pseudonym): I do think that eLearn has improved my results in this subject as I learned at my own pace and got to choose what elements of the topic to prioritize when revising.
>
> Daniel (pseudonym): I think it improved my learning where I think the in class teaching may have been slower to keep everyone at an even pace, but because of elearning I learnt more things that I would have in class because I used the resources I had to get a better mark on the test.

The mean for the Results scale was 3.64 (*SD* = 0.73, see Table 1), indicating students were satisfied with the structure and delivery of the online learning component. The mode for student responses in this scale was 4 (agree) for all questions. The majority of students (83%) said the organisation of each online lesson was easy to follow and 69% perceived online lessons help them better understand the content taught in class. The online content was easy for students to follow, and well sequenced. Students were particularly positive about the online, multiple-choice review quizzes at the end of lessons, as indicated in focus group interviews.

> Tim (pseudonym): The lesson quizzes helped me get better at the subject because it made me rethink what I had already learnt.
>
> Megan (pseudonym): The quizzes were good to test our knowledge and to help us improve.
>
> Bob (pseudonym): The lesson quizzes were very useful in terms of helping me understand the lesson

Conclusion

This aim of this study was to investigate student perceptions of a blended learning approach to teaching secondary Earth & Space science. The results show that students were generally positive about the blended learning approach, particularly as to the design and development of the curriculum unit. The results support the use of the Gradual Release of Responsibility (GRR) model, as these Year 10 students still preferred a high level of teacher support. This classroom study suggests blending learning can be one approach to increasing student engagement and success in secondary science The GRR model is useful for designing a blended learning approach.

The current task for science teachers is to increase student perceptions of and engagement with Years 7 to 10 science. Improving student's perceptions of science as a career option are linked to meaningful and valued experiences in junior secondary science. This research illustrates the potential of the GRR model, and how ICT integration in secondary science through blended learning has instructional possibilities.

References

ACARA. (2013). Australian Curriculum v5.1: Science. Retrieved 09/10/2013, from http://www.australiancurriculum.edu.au/Science/Curriculum/F-10

Ainley, J., Kos, J., & Nicholas, M. (2008). *Participation in science, mathematics and technology in Australian education*. (Reseach Monograph No. 63). from Austrailian Council for Educational Research (ACER) http://research.acer.edu.au/acer_monographs/4

AITSL. (2015). Evaluation of the implementation of the Australian Professional Standards for Teachers: Interim Report 2, 2014 Key Findings. Melbourne: Australian Institute for Teaching and School Leadership.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, N.J.: Prentice Hall.

Barbour, M. (2008). Secondary students' perceptions of web-based learning. *Quarterly Review of Distance Education, 9*(4), 357-371.

Boulton, H. (2008). Managing e-learning: What are the real implications for schools? *Electronic Journal of e-Learning, 6*(1), 11-18.

Calderon, O., Ginsberg, A. P., & Ciabocchi, L. (2012). Multidimensional assessment of pilot blended learning programs: Mazimizing program effectiveness based on student and faculty feedback. *Journal of Asynchronous Learning Networks, 16*(3), 23-37.

Carter, C. P., Reschly, A. L., Lovelace, M. D., Appleton, J. J., & Thompson, D. (2012). Measuring student engagement among elementary students: Pilot of the Student Engagement Instrument--Elementary Version. *School Psychology Quarterly, 27*(2), 61-73. doi: 10.1037/a0029229

Chandra, V. (2004). *The impact of a blended web-based learning environment on the perceptions, attitudes, and performance of boys and girls in junior science and senior physics.* (Doctor of Science Education), Curtin University of Technology. Retrieved from http://espace.library.curtin.edu.au/R?func=dbin-jump-full&local_base=gen01-era02&object_id=15943

Chandra, V., & Briskey, J. (2012). ICT driven pedagogies and its impact on learning outcomes in high school mathematics. *International Journal of Pedagogies and Learning, 7*(1), 73-83.

Chandra, V., & Fisher, D. L. (2009). Students' perceptions of a blended web-based learning environment. *Learning Environments Research, 12*(1), 31-44.

Chandra, V., & Watters, J. (2012). Re-thinking physics teaching with web-based learning. *Computers & Education, 58*(1), 631-640.

Chang, V., & Fisher, D. (2003). The validation and application of a new learning environment instrument for online learning in higher education. *Technology-rich learning environments: A future perspective*, 1-18.

Chen, W.-F. (2012). An investigation of varied types of blended learning environments on student achievement: An experimental study. *International Journal of Instructional Media, 39*(3), 205-212.

Cheung, W. S., & Hew, K. F. (2011). Design and evaluation of two blended learning approaches: Lessons learned. *Australasian Journal of Educational Technology, 27*(8), 1319-1337.

Chou, C.-T., Chuang, C.-p., & Zheng, B.-y. (2013). The study of blended learning on a vocational high school in Taiwan. *Journal of Modern Education and Computer Science, 5*(3), 1-7.

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education, 57*(2), 1469-1483. doi: 10.1016/j.compedu.2011.02.014

Fischer, D., & Frey, N. (2003). Writing intruction for struggling adolescent readers: A gradual release model. *Journal of Adolescent & Adult Literacy, 46*(5), 396-405.

Fisher, D., & Frey, N. (2008). Better learning through structured teaching: A framework for the gradual release of responsibility [Kindle Edition]: Ascd.

Goodrum, D., Druhan, A., & Abbs, J. (2012). *The status and quality of year 11 and 12 science in Australian schools*. from Australian Academy of Science http://www.science.org.au/reports/documents/Year-1112-Report-Final.pdf

Groundwater-Smith, S., Le Cornu, R. J., & Ewing, R. A. (1998). *Teaching: challenges and dilemmas*: Harcourt Brace.

Guzey, S. S., & Roehrig, G. H. (2012). Integrating educational technology into secondary science teaching. *Contemporary Issues in Technology and Teacher Education, 12*(2), 162-183.

Hayes, D. N. A. (2007). ICT and learning: Lessons from Australian classrooms. *Computers & Education, 49*(2), 385-395. doi: 10.1016/j.compedu.2005.09.003

Lee, S., & Tsai, C.-C. (2013). Tecnology-supported learning in secondary and undergraduate biological education: observations from literature review. *Journal of Science Education and Technology, 22*, 226-233. doi: 10.1007/s10956-012-9388-6

López-Pérez, M. V., Pérez-López, M. C., & Rodríguez-Ariza, L. (2011). Blended learning in higher education: Students' perceptions and their relation to outcomes. *Computers & Education, 56*(3), 818-826. doi: 10.1016/j.compedu.2010.10.023

Lyons, T., & Quinn, F. (2010). *Choosing Science: understanding the declines in senior high school science enrolments*. from National Centre of Science, ICT and

Mathematics in Education for Rural and Regional Australia (SiMERR Australia) http://www.une.edu.au/siemerr

Maynes, N., Julien-Schultz, L., & Dunn, C. (2010). Modeling and the gradual release of responsibility: What does it look like in the classroom. *Brock Education, 19*(2), 65-77.

Moskal, P., Dziuban, C., & Hartman, J. (2013). Blended learning: A dangerous idea? *Internet and Higher Education, 18*, 15-23.

Office of the Chief Scientist. (2012). *Health of Australian Science*. Canberra, Australia: Australian Government Retrieved from http://www.chiefscientist.gov.au/2012/05/health-of-australian-science-report-2/.

Office of the Chief Scientist. (2014). *Benchmarking Australian science, technology, engineering and mathematics*: Australian Government, Canberra.

Pina, S. (2012). From contact teaching to blended learning. *Interdisciplinary Studies Journal, 2*(2), 21-37.

Psycharis, S., Chalatxoglidis, G., & Kalogiannakis, M. (2013). Moodle as a learning environment in promoting conceptual understanding for secondary school students. *Eurasia Journal of Mathematics, Science & Technology Education, 9*(1), 11-21. doi: 10.12973/eurasia.2013.912a

Rosen, D., & Nelson, C. (2008). Web 2.0: a new generation of learners and education. *Computers in the Schools, 25*(3-4), 211-225. doi: 10.1080/07380560802370997

Rosenshine, B. V. (1995). Advances in research on instruction. *Journal of Educational Research, 88*(5), 262-268.

Rovai, A. P., Baker, J. D., & Ponton, M. K. (2013). Chapter 9: Correlations and prediction tests *A practitioners guide to reserach methods and SPSS analysis* (Vol. Kindle Edition): Watertree Press LCC.

Staker, H., & Horn, M. B. (2012). *Classifying K-12 blended learning*. from Innosight Institute http://www.innosightinstitute.org/innosight/wp-content/uploads/2012/05/Classifying-K-12-blended-learning2.pdf

Tobin, K. (1998). Qualitative perceptions of learning environments on the world wide web. *Learning Environments Research, 1*(2), 139-162. doi: 10.1023/A:1009953715583

Tytler, R., Haslam, F., Prain, V., & Hubber, P. (2009). An explicit representational focus for teaching and learning about animals in the environment. *Teaching Science, 55*(4), 21-27.

Waha, B., & Davis, K. (2014). University students' perspective on blended learning. *Journal of Higher Education Policy and Management, 36*(2), 172-182.

Wan, N., & Nicholas, H. (2010). A progressive pedagogy for online learning with high-ability secondary school students: a case study. *The Gifted Child Quarterly, 54*(3), 239-251.

Webb, M. (2013). Changing models for researching pedagogy with information and communications technologies. *Journal of Computer Assisted Learning, 29*(1), 53-67.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*, 89-100.

Wood, D., & Wood, H. (1996). Vygotsky, tutoring and learning. *Oxford Review of Education, 22*(1), 5-16.

Yapici, İ. Ü., & Akbayin, H. (2012). The effect of blended learning model on high school students' biology achievenemtn and on their attitudes towards the internet. *The Turkish Online Journal of Educational Technology, 11*(2), 228-237.