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In its first twelve years, the Journal logged over twelve million page views and more than two million downloads of Acrobat files of monthly journals and eBooks.

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Editorial

Editorial decisions

Donald G. Perrin

There are extensive studies to improve the quality of academic research publications and the quality of academic research. In the process, the role of editors and peer reviews has been subject to analysis. Unfortunately, many studies that raise questions for which better answers must be found, are privatized. For example, a recent study showed up to 50% of the best studies are likely to be rejected by Journals and 50 % of the worst studies will be published. If we assume most journals would agree on the top 25% and the bottom 25%, the variability that needs to be studied is the 50% in the middle of the scale. This middle ground is not well defined because of the different publication policies and editorial criteria.

Step 1: Review for compliance

Most journals set limits or standards based on topics, relevance to their mission, and perceived interests of their readers. There may be fees, mostly non-refundable, and requirements such as who is eligible to submit, number of words, quality of writing, format and style prescribed for publication, quality of research design, significance of findings, length and up-to-date bibliography, and enhancements such as illustrations, graphs, and tables. Unless there is a carefully written rubric, compliance decisions may be subjective. And if all guidelines are not exactly followed, or items are incomplete - such as missing biographies for secondary authors, excellent papers may be rejected without comment.

Assuming that most researchers are creative, entrepreneurial, and anxious to be published ahead of their competition, fitting their study into the required format may be challenging or even disparaging. Language and cultural differences in writing and interpretation are exacerbated for researchers with English as a second or third language, no formal education in the English language, or no English at all. And if their topic is new and unknown to the journal editors, it might not be considered or accepted.

Step 2: Send to reviewers

If the submission gets through the first filters, it is sent out to reviewers. How many of the problems in step 1 could occur in step 2? Most of them. Let's add a few more… You have an elite reader – top of his profession – a very busy person. a. He overlooks a major flaw leading to an embarrassing battle with your peers, or **b**. he rejects your article because he does not understand your world-shaking addition to the body of knowledge. And how rapid and complete was the response?

Step 3: Recommended for final editing and publication.

Your figures and tables follow no consistent format, or they were cut and pasted from another (unnamed) paper – maybe not even yours? The time and cost to check copyrights and reenter/reformat the data may put your paper at the bottom of the heap. Maybe it will get published next month – or the month after…. If illustrations are copied without reference or permission – you may be given the opportunity to fix it, or you may never see a letter of acceptance. Even the rejection letter may be delayed when you need it fast to find another publisher. If you sent to more than one publisher (a no-no) you have more problems. Your institution and two publishers are now involved in sorting out the mess. Good luck on that one.

Do these problem affect this journal?

These problems affect all journals to some extent. Add to this, IJITDL is all volunteer which makes management more complex. DonEl Learning, Inc. is being reconfigured as a non-profit DonEl Foundation so it can accept donations to improve the website and services. It is expanding the pool of peer reviewers (more in a later editorial). It insists on remaining cost-free to authors and readers and will not accept advertising within the pages of the journal. This has worked for 13 years for the International Journal of Instructional Technology and Distance Learning (IJITDL) and for the 9 previous years as the USDLA Journal (United States Distance Learning Association). We hope USDLA will allow us to add 1975-2003 to our web so it can continue to be available worldwide at no cost to researchers, innovators, practitioners, and administrators of education and training involving innovative technologies and/or distance learning.

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Editor's Note: A very detailed review of the literature determined what is known and what additional research is needed to build an effective mentoring program. This study was performed in the context off the multi-national and multi-cultural environment of the University of the Pacific which supports several small island nations in the south Pacific.

Peer mentoring program as a student support tool: a conceptual approach

Jashwini Narayan and Shavneet Sharma
Fiji

Abstract

This study recognizes and addresses a deficit in research on student support tool of peer mentoring. The purpose of this paper is to examine and better understand the relationship between peer mentoring and student academic success. Based on secondary reviews and a South Pacific university context, a conceptual model is drawn and a research methodology is proposed. This paper argues that a number of factors affect the effectiveness of peer mentoring which in turn affects student academic performance. This study is useful in setting the premise for future large scale empirical research. Tertiary institutions, student support learning centres, scholars and educators will benefit from the suggested model.

Keywords: University, Fiji, higher-education, peer-mentoring, student support, Pacific, developing.

Introduction

According to the UNESCO Institute of higher learning, Higher Education Institutes (HEIs) play an indispensable role in today's society. HEIs are often reminded to augment the skills and capabilities of a country (Miller & Packham, 1999). They have also realized that they need to produce quality graduates and this has led to the development of many student support tools (Ntkana, 2011). HEIs continue to provide learning and education to individuals in the face of rapid advancements in technology, shift in the demographic characteristics in countries and the on-going globalization process (Bridges, 2008). Such diversity in universities now calls for support mechanisms that not only consider student learning preferences but also their differences.

To assist students, universities provide a myriad of support services such as services for students with disabilities, career centers, counseling, psychological, scholarship and financial support, accommodation services, mentoring and academic tutorial programs (Scott S. , 1996). Academic support related services include academic tutorial programs, faculty and peer mentoring programs, academic and career advising, and social and personal adjustment initiatives (Bridges, 2008). All these are necessary to ensure that students transit smoothly into college and further, to facilitate quality of graduates. The quality of student or learner support is no doubt important and directly impacts the effectiveness of courses in terms of retention, as well as enabling the fulfillment of learning outcomes (Thorpe, 2002).

Learning in the Pacific is even more challenging given that much of it is controlled and directed by the teacher (Taufe'ulungaki, 2003) which has led to a lot of 'spoon-feeding'(Benson, 1995, p. 12; (Landbeck & Mugler, 1995; Latu & Young, 2004). As a result, students expect a similar learning environment even at tertiary levels. A non-threatening environment needs to be created where students can employ support tools that best suit them in achieving their learning goals. Scott (2012) recommends that first year students be prioritized, with provisions for later years.

Based on secondary reviews and a South Pacific university context, this paper draws a conceptual model that can help improve the effectiveness of peer mentoring. The university contextual evidence suggests that a number of factors influence effectiveness of peer mentoring which in turn affects student academic performance. The proposed methodology is demonstrated using the institutional case study example of the largest campus of a South Pacific university.

Globally, research that focuses on benefits of peer mentoring, and peer tutoring for peer mentors and tutors within an academic setting, is remarkably scarce (Clark & Andrews, 2009, p. 34). Internationally, calls have been made for better quality 'evidence based' educational research (Anderson T. , 2004, p. 263). According to Anderson (2004, p. 270), "we desperately need an increase in both quality and quantity of educational research and especially that devoted to learner services". As it is, "college practitioners, policymakers and advocacy groups are all exploring how to preserve delivery of existing supports, while at the same time, rethink ways to effectively engage more students with the assistance they need to succeed" (Booth, Cooper, Karandjeff, Purnell, Schiorring, & Willett, 2013, p. 2). There is a gap in literature when it comes to cross-organizational evaluations of mentoring on which future research can be carried out. The fact that very little attention has been afforded to peer mentoring, and that there are still ongoing student academic performance related issues across the globe, suggests that continuous research needs to be undertaken for further improvements. Clark & Andrew's (2009, p.3) paper did 'draw attention to the need for further empirical research in this area'. This paper contributes conceptually and contributes towards top-tier published research on developing South Pacific island tertiary institutions. "…with reference to challenges and prospects within the context of HEIs, there is unquestionably a dearth of research investigation in the Pacific" (Naz, Singh, Narayan, Prasad, & Devi, 2015, p. 79).

The purpose of this paper is to single out the student support service of peer mentoring to better understand it and to propose a conceptual model and methodology, drawn from literature and the baseline survey of a South Pacific University – The University of the South Pacific (USP), as the way forward for research on this support tool. Peer mentoring did prove to be the most popular academic support tool at USP (Singh, FBE Student Learning Support, Semester 1 Report, 2015). Inconclusive evidence on the effectiveness of peer mentoring (Paglis, Green, & Bauer, 2006) and Congos & Schoeps (1993) warrant further study. As Congos and Schoeps (1993) and Paglis et al. (2006) argue, there is no conclusive evidence suggesting that peer mentoring does improve student performance. While Miller & Packam (1999) showed regular attendance significantly improving student performance in terms of grades, their study sample was too small for generalizations which they themselves admitted to. They clarified that such evidence is not conclusive and that research by Congos and Schoeps (1993) did not inform of such a significant improvement in academic performance because of regular attendance (Miller & Packam, 1999, p.90). With the proposed research framework and methodology, this paper aims to enhance and extend knowledge and research in this area.

The remaining section of this paper is divided into four parts. The following section presents the literature review. The next section discusses the peer mentoring support tool in a University setting – the University of the South Pacific, leading to a conceptual model. The paper then highlights contributions so far, followed by future research suggestions. The paper closes of with conclusion, relaying key points.

Literature review

The types of student support provided at universities can be separated into two categories: 1) academic support and 2) non-academic support (administrative-institutional element) (Morgan, 2012; Prebble, et al., 2004; Simpson, 2002).

The first category of academic support includes the definition of course territory; explanation of concepts; exploring the course; analyzing feedback (on informal and formal assessments);

developing learning skills such as numeracy and literacy; chasing progress, following up on students' progress through the course; and enrichment which is about extending the boundaries of the course and sharing the excitement of learning (Simpson, 2002, p. 20)

In contrast, non-academic support involves “advising (giving information, exploring problems and suggesting directions), assessment (giving feedback to the individual on non-academic aptitudes and skills), action (practical help to promote study), advocacy (making out a case for funding, writing a reference), agitation (promoting changes within the institution to benefit students), and administration (organizing student support) (Simpson, 2002, p. 23).

McInnis (2000) states that academic learning support, counseling and employment services are the most important support services identified by students.

Peer mentoring

The term mentoring originates from the “story of Ulysses and his son Telemachus… the son was entrusted by his father into the care of a Mentor. The Mentor was old and wise and took charge of the son’s education, helping him mature (Woodd, 1997).

Mentoring “is a ‘personal/professional’ relationship and is often characterized by the Mentor helping the Mentee to discover his or her own capabilities and competences” (Scott, 2012, p. 18). The importance of mentoring cannot go unnoticed. From the 1980s, 1990s and 2000 literature (such as Sewart, 1983; Tait, 2000), it will not be incorrect to infer that regular contact with support staff apparently has a positive effect on student performance and that students often prefer face-to-face tutoring (Mowes, 2005). Mowes (2005) empirical research further highlights face-to-face tutorials and vacation schools as the most useful and effective student support services.

Student mentoring program is increasingly being used in universities throughout the world (Andrews & Clark, 2011). It has its origins in the USA since the early 1970s (Congos & Schoeps, 1993) in forms of Supplemental Instruction (SI) schemes (Martin & Arendale, 1993). SI is voluntary timetabled sessions on study skills conducted by the more successful students (Smith, Judy, May, Steve, Burke, & Linda, 2007). It reached the UK in the early 1990s (Rust & Wallace, 1994; Wallace, 1992).

Terminologies changes over time as focus changed to student-centered efforts. Peer Assisted Learning (PAL) encourages students to support each other and to learn co-operatively under the guidance of students from the year above” (Vierendeels). PAL is a “scheme that fosters cross-year support between students in the same course.

Mentoring in such a context incorporates roles of an “advocate, coach, teacher, guide, role-model, valued friend, door-opener, benevolent authority, available resource, cheerful critic, and career enthusiast” while the mentee is someone who is being guided, counseled and advised (Green, Herscowitz, & Sheppard, p. 4). Students who are successful at the second or third year levels are better equipped to assist students in the learning process (Martin & Arendale, 1993). According to Rust & Wallace (1994), students at the undergraduate level would prefer to engage in student facilitated learning than one that is facilitated by a teacher.

There are a number benefits for both the mentors and mentees who engage in the mentoring program (Ntkana, 2011). It has a positive impact on student performance and the marks students receive in their assessments (Ashwin, 2003; Bidgood, 1994; Black & MacKenzie, 2008, p. 3; Coe, et al., 1999; McCarthy, et al., 1997). According to Singh (2016), mentees stated that content is easier to understand due to the removal of unnecessary academic terminologies and lack of social barriers. Other benefits include an increase in confidence level, easy adjusting to university life, enhanced interpersonal contact, better self-esteem and personal growth (Capstick & Fleming, 2001; Ehrich, et al., 2004) and the opportunity to learn from one another in a manner that differs from a lecture setting (Anderson & Boud, 1996, p. 32).

Not only the mentees but the mentors benefit as well. Participation in the mentoring program benefits mentors by way of personal satisfaction and fulfillment (Ragins & Scandura, 1994. It also allows for personal development and reflection and enhances networking while facilitating sharing of ideas (Ehrich, Hansford, & Tennent, 2004). In addition, mentors gain from a sense of rejuvenation (Levinson, Darrow, Klein, Levinson, & McKee, 1978), creativity and energy from the mentees (Kram, 1985). Some gain a support base of students and obtain recognition from the university for his or her ability to teach, guide and advise students (Kram, 1985).

Overall, the perusal of literature suggests that mentoring enhances independent learning for both mentees and mentors (Jacobi, 1991; Topping, 1996) and brings about positive learning outcomes for both the parties (Astin, 1977; Ehrich, et al., 2004; Hansford, et al., 2002). However, like any support tool, the outcome can be very positive or even very negative and can either sustain the learner or leave him or her isolated (Thorpe, 2002). The obstacles, on the part of mentors can be in terms of poor planning (Ehrich, et al., 2004), mismatch between the mentor and mentee (professional incompatibility and can also be due to race and gender) (Ehrich, et al., 2004), time constraints, lack of training for mentors (Ehrich, Hansford, & Tennent, 2004), perception that mentoring is a burden and an increase in workload (Ehrich, Hansford, & Tennent, 2004) and the perception of unacceptable mentee behavior (unrealistic expectation from mentoring program and commitment issues) (Ehrich, Hansford, & Tennent, 2004). The mentees can also hamper the success of the program given lack of interest and the perception that asking for assistance demonstrates weakness on their part (Ehrich, Hansford, & Tennent, 2004). In addition, there can be administrative and managerial obstacles associated with the mentoring program. The manner in which the mentoring program is formally evaluated can also be an issue (Jacobi, 1991). For instance, some universities carefully monitor the value and success of the mentoring program while others do not.

Some similarities as well as dissimilarities of past and current research imply that there is no agreed or exhaustive list of factors affecting peer mentoring effectiveness. For instance, according to Douglas (1997) the coordination of the mentoring initiative across the organization and management and allocation of funds to run the program can be factors that hinder success. Others conclude that PAL adversely affects the quality of learning given more emphasis on succeeding assignments than deeper understanding of course materials (Ashwin, 2003; Capstick, 2004).

Proposed research methodology

To assist with conceptualization, this paper looks at the mentoring program run by the Faculty of Business and Economics (FBE) of the University of the South Pacific (USP). This paper argues that a conceptual model based on the contextual evidence of a South Pacific University such as USP, ‘the premier regional university in the South Pacific region’ (Naz, Singh, Narayan, Prasad, & Devi, 2015, p. 86), and the factors drawn from existing literature may shed light on issues and challenges facing peer mentoring. Literature has well established the relevance of the student support tools and their effects on student academic success. Additionally, the authors draw upon personal experience as students, and now as educators at this university.

USP was established in 1968 and is divided into three faculties: The Faculty of Business and Economics; The Faculty of Science, Technology and Environment, and The Faculty of Arts, Law and Education. “USP is one of the [only] two regional universities in the world…” (Naz, Singh, Narayan, Prasad, & Devi, 2015, p. 87). The University is owned by 12 countries in the South Pacific which has resulted in students enrolling from diverse learning and cultural backgrounds. Both Thaman (1996) and Chu (2012) suggest greater sensitivity towards student learning experiences and the teaching context of the Pacific since there exists a gap between how students are taught in their culturally embedded environments in their home countries (this being 'teacher directed and controlled' (Taufe'ulungaki, 2003, p. 31) and how they are expected to learn in formal settings like that of USP (Thaman, 1996).

At USP, a Senior Peer Mentoring Program (SPMP) was piloted in 2005 (Anzeg). The Center for Excellence in Learning and Teaching (CELT) formally rolled out the program in 2006 supporting 162 mentees (Anzeg, n.d.; Singh, 2016). The aim of this program has been to reach out to students who are at risk, make learning fun and accessible and building bridges to close the gap between the students and the teacher. Some of the academic support services offered at USP include drop-in services, academic skills workshop, guest sessions and peer assisted study. According to Singh (2015), peer mentoring is the most popular/preferred academic support tool. Its popularity was in terms of frequency and the number of students engaging in the program - 807 students attended the sessions during semester 1, 2015 of which 63% were regular attendees. Such a support is even much more important in recent years given the less strict and lower mark high school admission requirement. "This could imply, as tertiary institutions have already experienced, an influx of inadequately prepared ('underprepared') students (Ntkana, 2011, pp. 18-19).

In 2009, CELT was rebranded as Student Learning Support (SLS) and later in 2011, each faculty SLS recruited and trained mentors under SPMP (Singh, Some Insights into a Peer Mentoring Programme, 2016). Mentors for this program are selected on the basis of their Grade Point Average, mentoring skills and a different country background to enable a good match between the mentors and the mentees; the third attribute being a challenge since other pacific islanders hardly apply for mentor positions (Anzeg). The mentoring program provides assistance in terms of exam preparation (going through past year papers), research for assignments, referencing, tutorial questions, understanding the content of the lecture notes and understanding the assignment question.

In 2014, SPMP was replaced with the international Peer Assisted Study Session (PASS) concept (Singh, Some Insights into a Peer Mentoring Programme, 2016). PASS differs from SPMP in that it is collaborative and nurtures self-directed learning approach (Singh, Some Insights into a Peer Mentoring Programme, 2016). The title 'peer mentor' also changed to 'PASS Leader' given a move away from the traditional hierarchical role of the mentor. "The emphasis of the scheme, driven by the vision of the coordination team is to provide, in a sense, a product (mentor) that is desired by the customer (student)" (Miller & Packham, 1999, p. 84).

Mentoring has its own challenges. Some of the challenges faced by SLS include creating awareness for students at risk (despite regular promotions through USP wide emails distribution, flyers, brochures, notice boards, USP's own magazine – USP Beat, its radio station – Radio Pacifica and orientation sessions), difficulties in maintaining mentees as some students only attend when assignments fall due; timetable and scheduling issues, room allocation and, mentors not being given a work station (Anzeg). The mentoring report also states some student suggestions/feedback such as more communication about the availability of mentors for particular courses by the lecturers. In addition, students expressed the need for mentors from different Pacific Islands to make learning and communication easier (Anzeg). Mentees also indicated that timely notification should be provided if and when there is a change in mentoring schedules.

As per this paper's research question and, in keeping consistency with the literature reviewed and USP's contextual evidence, this paper suggests a model, illustrating the relationship between peer mentoring and student academic success. In the perusal of literature review, the authors of this paper paid special attention to the small scale study undertaken at USP by Singh (2016) and USP SLS's evaluations. The USP mentoring report (Anzeg) and Singh's (2016) small scale research provide base level evidence of factors identified by Student Learning Support (SLS) and the mentees. These prove that mentoring does need improvement and highlights factors that should be thoroughly researched into on a larger scale to substantiate the claims of SLS, Singh (2016) and the mentees. USP SLS's evaluation is the baseline data that is regularly collected. Such data can provide robust evidence on predictable issues (Thorpe, 2002, p. 257). The findings of such research when taken together with earlier studies conducted elsewhere help conceptualize peer mentoring to better inform and improve practice.

The factors that appeared similar in literature, some of which were empirical in nature, were thus noted. In their paper, Clark & Andrews (2009, p.3), draw attention to the difficulties of conceptualizing mentoring. They agree with Chandler & Kram (2005), who argue that while much of the thirty or so years of literature focus on mentoring, such literature failed to fully conceptualize what 'mentoring' encompasses. This does not mean that models are not available but there is none that specifically addresses mentoring effectiveness, this being one of the major contribution of this paper. "Whilst there exist substantial literature pertaining to traditional conceptualizations of mentoring, literature focusing on peer mentoring specifically is scarce" (Clark & Andrews, 2009, p. 14). Existing models by Floyd & Casey-Powell (2004) and Mowes (2005) are more about the overall support services for distance mode learning.

From Booth's et al. (2013) research, it is clear that students usually identify more than one factor. In this paper, the factors of mentoring session awareness, maintaining mentees, timetable, room allocation and mentor workstation are drawn from the USP SLS baseline reports. There are certain similarities between these factors and those identified by other researchers. For instance, the workstation factor is similar to 'learning environment' of Smith's et al. (2007) study. The session awareness and timetable factors are similar to 'not knowing about mentoring times' of Singh's (2016) study, 'timetabling/operational shortcoming factor of Capstick's (2004) study, 'accessibility of information for students' factor of Scott's (2012) study and 'widely advertise and inform students' factor of Booth's et al., (2013) research.

Mentor country background identified by mentees is drawn from the USP Mentoring Report (2005-2009) by Anzeg (n.d.).This factor is given importance since the differences in mentor-mentee backgrounds or rather 'unsuitable pairings' (Ehrich, Hansford, & Tennent, 2004) can affect mentoring relationships. Mentor-mentee relationship must consider demographic factors (Chandler & Kram, 2005).

The factors of attitude, attributes (not only subject matter expertise but also counseling ability), role and availability; accurate notification; communication with support staff and mentor; and previous experience are drawn from Mowes (2005) study with 'accurate notification' being common timetable/awareness related factors in abovementioned studies. Previous experience as 'previous years' work' was also identified by Smith et al. (2007). The attitude, attributes, role and availability of mentors matter since "learner support, in contrast to the study resources, should not be uniform, but should be adapted to and responsive to the needs of each learner" (Thorpe, 2002, p. 251). Awareness of support services appears to be the most common factor amongst various studies. It is also a factor identified by Mowes (2005). This is an important factor since it leads to underutilization of student services leading to poor performance and the inability to achieve full potential ultimately leading to withdrawal form universities (Ntkana, 2011).

The resulting model is considered wholesome since it not only takes into account the perspective of students but also the issues faced by SLS. Sewart (1993) emphasized the important role the learner support staff play as intermediaries between the HEIs and the students. "Various studies contextualize mentoring from an organizational perspective, focusing specifically on mentoring relationships within a work environment" (Clark & Andrews, 2009, p. 16). It is the contention of the authors of this paper that current research on student support services have either largely focused on instructors perspective, mentor or student perspective. The authors thus bring together the views of both the support staff and the students to emphasize an integrated system since "… well-integrated student support services can cultivate a supportive campus environment and positively affect student success" …, thereby increasing student satisfaction, retention, and graduation rates" (Bridges, 2008, pp. 2, 4).

In the opinion of the authors of this paper, peer mentoring faces several challenges as mentioned below in the hypotheses which when taken together and addressed appropriately, will enhance the effectiveness of the mentoring programme.

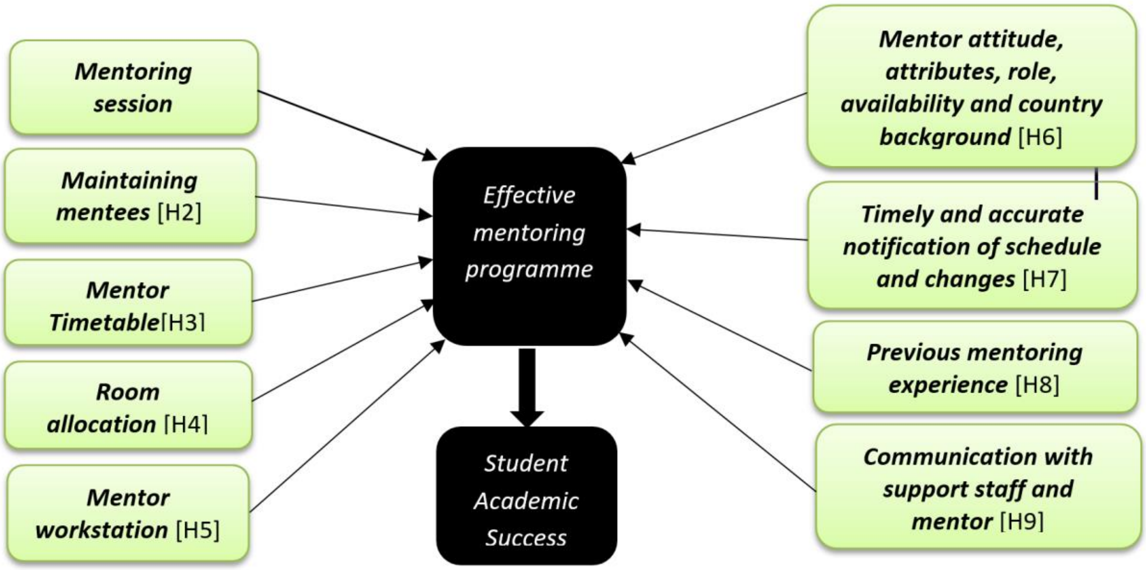

Figure 1: Factors affecting mentoring programme that in turn affect student academic success, prepared by Narayan & Sharma (2016) for this paper.

- H1: Mentoring session awareness affects effectiveness of mentoring programme
- H2: Maintaining mentees affects effectiveness of mentoring programme
- H3: Timetable affects effectiveness of mentoring programme
- H4: Room allocation affects effectiveness of mentoring programme
- H5: Mentor workstation affects effectiveness of mentoring programme
- H6: Mentor attitude, attributes, role and availability and country background affect effectiveness of mentoring programme
- H7: Timely and accurate notification of schedule and changes affect effectiveness of mentoring programme
- H8: Previous mentoring experience affects effectiveness of mentoring programme
- H9: Communication with support staff and mentor affect effectiveness of mentoring programme

This study is a conceptual approach and builds on current work. The next phase of this work is to collect relevant primary data to test the conceptual model, styled similar to the research methodology utilized by Mowes (2005). In this regard, a survey can be undertaken amongst students of any tertiary institution like USP followed by some in-depth interviews, focus groups with prompts which may not only put forth examples but also describe feelings/emotions of respondents as well as illustrate ways in which services can be enhanced (Fisher & Baird, 2005). In his study, Capstick (2004) used qualitative methodology to investigate and describe benefits and shortcomings of Peer Assisted Learning (PAL). According to Smith et al. (2007), there seems to be little qualitative literature explaining why students do or do not engage in PAL schemes. Capstick (2004) argues that when compared with quantitative outcomes, qualitative studies portray the mentoring scheme better since these are more evident and demonstrable. This conceptual paper, however, agrees with Ntakana's (2011) recommendation of a combination of qualitative and quantitative approaches since qualitative approach allows for deeper understanding of benefits and challenges while quantitative allows for quantifiable measurements and analysis (Clark & Andrews, 2009). Furthermore, quantitative data can provide with basic research evidence (Möwes, 2005) and allows for generalizations but fails to provide evidence on attitudes and activities (Thorpe, 2002), while qualitative data provides with examples and explanations behind quantitative findings (Möwes, 2005) and taps into student learning center staff and mentee emotions/feelings.

The research population of this study can be the student learning center staff and mentees. All student learning center staff and a random sample of mentees, desirably 50 percent or more of the first year student mentees will allow for appropriate generalizations. Prior to research, appropriate formal approval must be sought from the subject university in line with research ethics. For tertiary institutions like USP that has campuses/centers spread out in different countries, a stratified random sampling technique can be used to come up with a representative sample from the island countries of the South Pacific region and also from the different campuses. However, the authors suggest that samples be drawn from the main campus given the variation in the level of student support services offered in each center/campus. The largest campus, in USP's case the Laucala Campus in Fiji islands will be more meaningful. A single regional center also ensures that interviewees are subjected to similar student support environment and rules out any effects of extraneous variables in response evaluation (Möwes, 2005).

Such an investigation will build upon and a larger sampled study when compared to the 2016 small scale study by Singh (2016) at USP with a response rate of just 12%. Low response rate fails to provide an in-depth understanding of the examined situation (Robson, 1997, p. 128). However, Singh (2016) admitted to this flaw expecting her study to lead to a more extensive research at USP. Singh (2016) carried out a small scale online survey with only six questions to assess mentee satisfaction of a peer mentoring session, but this can be utilized as a pilot study to build upon.

A semi-structured self-administered questionnaire with structured questions and open ended questions was developed for data collection. The structured questions for quantitative data utilizing scale, 'yes' and 'no', and open-ended questions are supported by qualitative data (Möwes, 2005). Questions also cover areas of deeper learning in peer mentoring sessions. Smith et al. (2007, p.100) highlights this as one important area for future research.

The questionnaire is comprised of three sections including 'adjusting to university life'; 'interpersonal contact'; and 'increase in confidence level', 'self-esteem' and 'personal growth'; drawn from the studies of Capstick & Fleming (2001) and Ehrich et al.(2004) with specific questions relating to factors mentioned in the above model. The age factor should also be given some importance since previous studies (Miller & Packham, 1999; Gibbon & Saunders, 1996) noted differing conclusions on whether or not mature students dominate the session attendance. "Data could be prepared for computer entries, cleaning and processing, using the Statistical Package for Social Sciences" (SPSS) (Möwes, 2005). Descriptive analysis, chi-squares and regression can be performed to test the relationship/impact of the various variables. Structural equation modelling can be done to test the modulating variables. For qualitative data – open ended responses, focus group responses and in-depth interviewee responses, a spreadsheet can be created to log interviewee responses and reactions. These can then be analyzed using thematic analysis of holistic, selective or highlighting approaches (Van Mannen, 1990) similar to Singh's

(2016) and Smith's et al (2007) study. While the holistic approach seeks the overall meaning of text, selective approach focuses on phrases or sentences that stand out, and the highlighting approach closely examines each statement (Smith, Judy, May, Steve, Burke, & Linda, 2007).

Contributions and future research

Contributions

The contribution of this study is threefold. First, the study advances research work in the area of peer-mentoring, prior research on the effectiveness of which is said to be inconclusive (Clark & Andrews, 2009, p. 31).

Second, the suggested model helps to better understand how the involvement of student learning support centres can improve mentoring outcomes and student satisfaction. This paves the way for development of even more effective models. Researchers continue to suggest likewise. "…, student support services must be redefined and implemented systematically, and they must be continually evaluated to ensure satisfaction and success among all students" (Floyd & Casey-Powell, 2004, p. 63). However, there are challenges of contextual implications of adopting model of elsewhere which may not work in another context. Nonetheless, "given the regional and international position of USP as an institution of HE, local best practice also need to be shared, transferred and experimented with, while the best global practices should be studied for its relevance and further contextualized to scrutinize the potential of the models/framework…" (Naz, Singh, Narayan, Prasad, & Devi, 2015, p. 89). In this regards and thirdly, this study sheds light on small pacific developing island students which have not been given due consideration in many HEI studies. The suggestions are nonetheless applicable to HEIs elsewhere.

This study overall contributes to the ongoing literature – it contributes to how the research gaps identified by previous researchers can be addressed. For instance, Clark & Andrews (2009, pp.37-38) highlighted gaps in forms of questions such as "How can peer mentoring and peer tutoring be conceptualized for the purposes of empirical research". This paper, through its proposed research methodology paves the way for empirical research to fulfill such research gaps.

With its specific focus on peer mentoring, this study marks the significance and relevance of enhanced student oriented peer mentoring sessions and…. 'could offer universities a unique appointment to augment its graduates in terms of employability' (Miller & Packham, 1999, p. 94). Policy makers, university management, student support centres, academics and scholars will benefit from this paper's research framework suggestions. The University practitioners, managers and funding agencies, may find this research particularly meaningful when considering student support policies and budget allocation to student support centres.

Limitations and future research

This paper is based on secondary reviews, small scale study of Singh (2016) and the base line surveys carried out at the University of the South Pacific by Student Learning Support. Publication of such research can result in replication elsewhere in different contexts, allowing for further research and introduction of innovative methodologies. The study should not be taken to exemplify the entire mentoring scenario of Higher Education Institutes. Nonetheless, it is envisaged that the study will inspire scholars to further scrutinize the subject matter with larger scale studies, using the model and methodology proposed. Above all, the model and methodology opens up a fresh perspective to investigate factors influencing success of peer mentoring.

Conclusion

This study proposes a qualitative as well as quantitative research methodology to inform, guide and better evaluate the current practice of the under-researched area of peer mentoring, drawing factors from previous research. This paper considers this as a novel lens to the interplay of factors affecting the effectiveness of the mentoring programme. New research paradigms can bridge the gap between scholarship and practice and can assist in significant improvements to the quality and cost effectiveness of such services (Anderson T. , 2004). The paper not only contributes to ongoing student support – in particular peer mentoring literature, but also contributes towards little top-tier published research on student support efforts in the South Pacific.

On an international note, educational research needs some limelight – as, unlike other disciplines, research in this discipline is neither valued nor well-funded which may be due to a lack of a sustaining research culture (Anderson T. , 2004, pp. 261-262).

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Editor's Note: It is 50 years since Broadbent confounded the research community with the idea that multiple channels of information did not necessary result in greater learning. Robert M. W. Travers was principal investigator for ***Studies related to the design of audiovisual materials*** based on the affordance that "*when significant information is coming through one sense modality, then there is likely to be partial blocking of information coming through other senses."* This editor has always advocated modulating the senses for maximum affect as a conductor would an orchestra, using the entire sensorium where appropriate. This paper finds a more practical approach – Return on Investment (ROI).

The multimedia principle:

a meta-analysis on the multimedia principle in computer-based training

Ray Pastore, Jessica Briskin, Tutaleni I. Asino

USA

Abstract

This meta-analysis sought to examine whether the multimedia principle applies to computer-based training (CBT), specifically looking at this principle's effects on different levels of learning (low- and high-level knowledge). Results of the meta-analysis revealed a significant difference ($p<.001$) with a medium-high effect (r=.48) on achievement when learners were presented with single vs. multiple representations in a multimedia environment. There was a significant difference ($p<.001$) and a medium-high effect (r=.45) for low-level (rote) knowledge; however, there was not a significant difference (p=.06) for high-level (meaningful) knowledge but there was a high effect (r=.5). The most surprising finding of this analysis was the limited number of studies that met the inclusion criteria: presented via computer, delivered to adult learners, and used static image representations (not video or animations). After an exhaustive review of the literature, there were only five studies with eleven effect sizes that could be used. For designers and developers to justify the time and cost to develop multiple representations for CBT, there must be a significant body of work to help quantify the return on investment. The findings of this meta-analysis are intended to help guide instructional designers and multimedia developers using CBT as an instructional solution.

Keywords: multimedia principle, multimedia, multiple representations, cognitive theory of multimedia development.

Introduction

In educational discourse, multimedia often refers to the visual representation of material using both text and graphics to meet learning objectives (Mayer, 2009). Today, most technology-based learning relies on a foundation of research based on multimedia (Pastore, 2014). The promotion of learning through multimedia relies on the understanding that human beings have the ability to incorporate different modalities into how they experience the world. Moreno and Mayer (2000) elucidate this through an example of lightning, describing how individuals engage multiple senses by associating the visual cues of lightning with the sound of thunder. Verbal and visual representations can also be incorporated into a mental model, as is the case when watching lighting while also listening to an explanation of how lightning occurs. It is important to understand these concepts when teaching with technology because these tools exist to create computer-based instruction that is better aligned with how people learn. It is based on this goal of enhancing learning by decreasing the load on working memory that different principles of design in multimedia, such as the multimedia principle, have emerged.

What is the Multimedia Principle?

The multimedia principle, advanced by Richard Mayer (2001, 2009), reasons that learning is more effective when it involves words and pictures, that explain for one another, as opposed to words alone (multiple vs. single representations). The argument espoused by this principle is that individuals are more likely to build visual and verbal mental models when presented with both text and picture representations. On the other hand, presenting learners with only text leads to difficulty connecting verbal and visual models. Initial research around the multimedia principle focused on text and static or animated images (Mayer, 1989; Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer & Gallini 1990); however, more recently this principle has been examined in different contexts including interactive media, virtual reality, simulations, and video.

The multimedia principle is supported by a number of theories including cognitive load theory (CLT) and the cognitive theory of multimedia learning (CTML). The CLT is concerned with the amount of processing activity that is imposed on working memory (Cooper, 1998). CLT starts with the premise that although long-term memory may be limitless, there is a limit to how much information working memory can hold (Baddeley, 1986). Consequently, instruction and learning experiences should be structured in such a way that recognizes this limitation. Specifically, designers should be concerned with assuring that the limits of the learner's working memory load are not exceeded when processing the information presented (Kirschner, 2002).

The cognitive theory of multimedia learning (CTML) is based on dual-coding theory, cognitive load theory, model of working memory (Baddeley, 1992), generative theory (Wittrock, 1989), and Mayer’s (1996) select, organize, and integrate (SOI) model of learning. The CTML argues that learners have two systems, a visual information processing system and a verbal information processing system, which together explain how multimedia learning is cognitively processed. At its broadest and simplest form, “learning is becoming able to do something one was unable to do before” (Cronje, 2016, p. 5). On a more complex level, Mayer & Moreno (2003) argue that human learning is a deep cognitive process predicated on three assumptions: dual channel, limited capacity, and active processing.

The dual channel assumption, informed by the work of Paivio’s (1986) dual-coding theory and Baddeley’s (1998) theory of working memory, assumes that the “human information-processing system consists of two separate channels—an auditory/verbal channel for processing auditory input and verbal representations and a visual/pictorial channel for processing visual input and pictorial representations” (Mayer and Moreno 2003, p. 44).

The limited capacity assumption, supported by Chandler and Sweller’s (1991; Sweller, 1999) cognitive load theory and Baddeley’s (1998) working memory theory, postulates that there is a limit on how much information humans can process. In other words, there is a limit on how much cognitive processing can occur in the visual and verbal channels at any one time. Similarly there is a limit on how much cognitive processing can occur in each individual at any one time.

In the active processing assumption, which is anchored in the work of Wittrock’s (1989) generative-learning theory and Mayer’s (1999, 2002) SOI theory of active learning, it is assumed that “meaningful learning requires a substantial amount of cognitive processing to take place in the verbal and visual channels” (Mayer & Moreno 2003, p. 44). Put differently, paying attention, organizing materials, and integrating presented materials into existing knowledge takes a significant amount of cognitive processing power.

The unifying assumption among the three principles of CTML is that, given what is currently known about how humans learn, it is necessary to find ways to reduce taxing cognitive processes. A number of studies support this conclusion and show that learners who receive multiple representations vs. just a single representation have increased retention of content and a deeper understanding of the material (Hegarty, & Just, 1993; ChanLin, 2001; Cuevas, Fiore, & Oser, 2002).

Research on the Multimedia Principle

Mayer and colleagues developed the multimedia principle based on the assertion that individuals learn more deeply from words with complementary graphics than from words alone (Clark & Mayer, 2011). This assumes that the instruction containing words (i.e., spoken or written text) and graphics (e.g., illustrations, charts, photos, animations, video, etc.) are intended to foster learning (Mayer, 2009). A myriad of studies suggest that applying multimedia-learning principles when designing and developing educational materials enables deep and meaningful learning (Mayer, 2001). While deep, meaningful high-level learning is usually the end goal, both low- and high-level learning are important in fulfilling instructional objectives (Issa, Schuller, Santacaterina, Shapiro, Wang, Mayer, & DaRosa, 2011).

A number of studies on single vs. multiple representations were conducted over 40 years ago by Dwyer and colleagues (Dwyer, 1978; Lamberski & Dwyer, 1983; Dwyer, & DeMalo, 1983). A meta-analysis on Dwyer and colleagues' studies found that overall, in both the adult (university) and high school (secondary) populations, there was a significant difference in retention but not transfer/problem solving when multiple representations were used for learning (Reinwein and Huberdeau, 1998). More recently, Pastore (2010) found similar results during a study in which 76 university students were presented with either narration on its own or narration with images in a computer-based training environment. Results indicated that there was a significant difference in retention but not problem solving (effect size was .07). Participants in the narration only group scored higher than the participants in the visual-narration group. This result contrasts with findings in experiments conducted by Mayer and colleagues, who found an average effect size of 1.5 for transfer knowledge with an 89% overall gain in multiple representation groups when compared to single representation groups (Mayer, 2001; 2009). Additionally, a number of recent studies by Mayer and colleagues have found significant differences in both retention and transfer in multimedia studies (Sung & Mayer, 2012; Eitel, Scheiter, & Schuler 2013; Issa, Mayer, Schuller, Wang, Shapiro, & DaRosa, 2013). For example, Hegarty and Just (1993) put 47 university students into single vs. multiple representation groups and found that the group presented with multiple representations performed significantly better on achievement tests measuring high-level knowledge. Cuevas, Fiore, and Oser (2002) found similar results in their experiment, which found differences for both retention and transfer.

Although studies show consistent differences between single and multiple representation learning in terms of rote-level knowledge, there is some disagreement in the literature about the results when it comes to meaningful learning in a multimedia environment. Additionally, a recent study by Pastore (2014) on learner preferences of multimedia found that participants overwhelmingly preferred multiple to single representations for learning. In response, designers need to decide if the potential learning increase, if it exists, and learner satisfaction are worth the time and cost to develop multiple representations.

Multimedia in practice

Putting the multimedia principle into practice can be a challenging task for an instructional designer because graphic capabilities are not always part of an instructional designer's skillset. As a designer, it is important to keep in mind that graphics should always be relevant to the words on the page/screen (Scnotz & Bannert, 2003). Images can be developed by an instructional designer or downloaded from an image gallery, but most often development requires another team member or individual with graphic design skills. This individual will help in the development of graphics as well as design elements such as typography, color, white space, composition, etc. This often accrues an extra cost in the development process. However, with the prevalence of authoring tools such as Articulate Storyline and Adobe Captivate, nearly any designer can incorporate graphics into text easily with minimal training. Literature on the multimedia principle includes multiple types of visual representations other than static images (Mayer, 2014). Other possibilities include animations and video, which can require a computer programmer or videographer in addition to a graphic artist. Additionally, studies on both video and animation have exhibited improvements in learning in a multimedia environment (Rusli, Bali, & Puputan, 2015; Scheiter, Schuler, Gerjets, Huk, & Hesse, 2014). However, while animation and video have been studied with the multimedia principle, they are outside the scope of this paper, which focuses only on static images. This decision is explained further in the methods section.

Thus, the development of a multimedia program can be done by the instructional designer, but the graphic representations may need to be developed by a graphic artist or other trained professional. This can add a significant cost to training. For example, according to the Bureau of Labor Statistics (2014), graphics designers can make as much as $80,000 a year. Instructional designers must be able to show correlated learning improvement in order to justify the high cost of graphic development. For these reasons, it is imperative that analyses of the multimedia principle be conducted so that designers can make decisions based on quantifiable data.

Purpose

The purpose of this meta-analysis is to examine the effects of the multimedia principle (single vs. multiple representations) on CBT. A meta-analysis on single vs. multiple representations in a learning environment was conducted in the 1990s using Dwyer and colleagues' research. This analysis revealed that, at the university level, there was a significant difference in low-level knowledge (retention); however, the results were not significant for high-level knowledge (transfer) (Reinwein & Huberdeau, 1998). More recently, Mayer and colleagues (2014) conducted a myriad of studies on the multimedia principle, finding significant differences in learning and concluding that "overall, the multimedia principle generally shows weaker effects for retention than for deeper understanding" and that there are generally "smaller average effect sizes for retention compared to transfer" (Butcher, 2014, p. 179). As a result, it is hypothesized that the multimedia principle will demonstrate a positive effect on learning in a computer-based instructional environment at all levels, including low- and high-levels. By showing how both verbal and visual representations impact learning, these findings will help instructional designers and multimedia developers feel confident in recommending CBT as an instructional solution by giving them a means to justify the time and expense required.

Method

A meta-analysis was conducted based on criteria set forth in research by Brewer (2009) and Field and Gillett (2010). This included selecting variables and inclusion criteria, locating and then coding studies, and analyzing and interpreting the results.

Locating studies and inclusion criteria

The search was exhaustive and examined journals, books, and appropriate reference lists (Lipsey & Wilson, 2001; Glass, 2006). To begin the search, the Educational Resources Information Center (Eric) and EBSCOhost Online Research Databases were reviewed. Additionally, Google search engine and Google Scholar were utilized. Terms searched included: "multimedia", "multimedia principles", "dual-coding", "cognitive theory of multimedia learning", "multiple representations", etc. Additionally, sources were found in relevant articles and significant works on the subject (e.g., Cambridge Handbook of Multimedia Learning, 2005; 2014 and Multimedia Learning, 2001; 2009).

First, titles, keywords, and abstracts were assessed and then full reviews were done on relevant articles. Reviews were completed by the three authors of this paper. There were a total of 45 articles located for further review. Those 45 were analyzed to determine whether they met additional criteria (Lipsey & Wilson, 2001), such as testing single vs. multiple representations, using static images not animations/video for the visual representation, and occurring under experimental conditions. Eleven studies that met these criteria were selected for additional analysis and to determine whether they met the following criteria for inclusion in the meta-analysis: Multimedia principle, pre-test, adult learners, and computer-based training.

For single vs. multiple representations (Multimedia Principle) criteria, the representations must have complemented one another. This is in line with the Multimedia Principle (Mayer, 2005), but not in line with dual-coding, which does not require that multiple representations explain for one another in order to improve learning. However, research has found that representations which are poorly designed or do not belong may in fact hinder learning (Schnotz & Bannert, 2003).

A pre-test was used as exclusion criteria to account for the group's existing knowledge prior to the statistical comparisons. The selected pre-test could not be the same as the post-test in order to avoid compromising the internal validity of the study (Ross & Morrison 1996). Consequently, a pre-test that was not exact, yet analyzed prior knowledge of the topic, was deemed acceptable.

Studies that utilized adolescents were also eliminated. This paper focused on adult learners, therefore any study using learners under the age of 18 was eliminated. Additionally, if the studies were not conducted on a computer, they were eliminated. This study is focused on the use of the multimedia principle in computer-based instructional environments (e.g., eLearning, computer-based training, etc.). As a result, paper-based comparisons were not included. While this paper is not focused on media comparisons, Ross and Morrison (1996) have stated that overall there is no difference in media comparison studies. However, studies, such as Clariana and Wallace (2002), have found a difference in achievement between computer and paper-based assessments.

Millions of dollars are spent each year on CBT with the multimedia principle as a guide. The intention of this study is to provide data specifically for the population involved in computer-based instruction. Therefore, research which did not focus on CBT and the multimedia principle was excluded. To ensure that research was current, only articles published after 1992 were considered. Prior to 1992 computers graphics were unable to match the quality of print graphics and therefore the research completed prior to this time were not pertinent to this study (Noyes & Garland, 2008). Finally, studies that did not provide statistics required for effect size were eliminated. Of the 11 studies that were analyzed further, five met the guidelines. Of those five studies, there were 11 effect sizes (see Table 5).

Coding

Coding was conducted independently by the three authors of this paper. The lead author analyzed all papers while the other two authors each coded half. Any discrepancies were discussed among the team and further analyzed as a group to reach a consensus with no disagreements among the raters. The following codes were used: high- vs. low-level knowledge, reliability, and validity.

High- vs low-level knowledge

Mayer (2014) describes two desired outcomes in multimedia learning; rote- and meaningful-learning. Rote learning is assessed via retention tests such as recall and is described as "knowledge that can be remembered but cannot be used in new situations" (Mayer, 2014, p. 21). Meaningful learning is assessed via transfer tests such as problem solving and is described as knowledge that is "organized into an integrated representation" that can be applied to new situations (Mayer, 2014, p. 21). Throughout the rest of this paper, the terms low- and high-level knowledge will be used to refer to rote and meaningful learning outcomes.

Reliability

Reliability of the assessment instrument is used to indicate measurement error consistency over time (Wells & Wollack, 2003; Drost, 2011). As a result, internal consistency statistics such as Cronbach's alpha, Inter-Rater, and others were reported when available.

Validity

Content validity was examined to ensure that the test measured the intended target. Content validity was deemed successful if there was an indication that an expert reviewed the materials (content and test) to ensure that they were correct (Drost, 2011).

Limitations

One potential cause for bias in a meta-analysis is that significant findings are more likely to be published than non-significant findings. Researchers do not submit studies that lack significant results (Dickersin, Min, & Meinert, 1992). Additionally, Brewer (2009) notes that meta-analysis tends to lump studies with weak methodologies in with studies that have strong methodologies. Note that this study focused only on the multimedia principle in a computer-based environment using static images and did not consider other principles derived from the cognitive theory of multimedia learning (e.g., modality, split attention, redundancy, coherence, etc.) or video or animation multimedia.

Results

Statistical analysis

Statistical analysis was completed in SPSS following the method set forth by Field and Gillett (2010). Effect size, which was calculated as Pearson's correlation coefficient (*r*), was used so that it was possible to compare studies that measured different variables and used different scales of measurement (Field & Gillett, 2010). Once the effect size (*r*) was calculated, meta-analysis calculations were conducted based on the Hedges and Vevea random effects model (Hedges & Vevea, 1998). A random effects model was selected so that unconditional inferences could be made. A fixed model is limited to only conditional inferences (Hedges & Vevea, 1998), and would not have been suitable for this study. The I^2 heterogeneity index was calculated using the Higgins, Thompson, Deeks, and Altman, (2003) method, which suggests that low levels are those less than 25%. Publication bias was detected via Rosenthal's (1979) fail-safe *N*.

Table 1
Stem-and-leaf plot for all effect sizes

Stem	Leaf
-.1	
0	3
.1	3, 9
.2	1, 5
.3	7
.4	6
.5	1
.6	7
.7	4
.8	
.9	4
1.0	

Table 2
Stem-and-leaf plot for high-level knowledge effect sizes

Stem	Leaf
0	
.1	3
.2	1, 5
.3	
.4	
.5	1
.6	
.7	
.8	
.9	4
1.0	

Table 3
Stem-and-leaf plot for low-level knowledge effect sizes

Stem	Leaf
-.1	
0	3
.1	9
.2	
.3	7
.4	6
.5	
.6	7
.7	4
.8	

Per the recommendation of numerous authors (Tukey, 1977; Rosenthal, 1995; Field & Gillett, 2010), Stem-and-leaf plots for all effect sizes, high-level knowledge effect sizes, and low-level knowledge effect sizes were included to show the distribution of effect sizes (see Table 1, Table 2, and Table 3).

Meta-analysis of all effect sizes

This meta-analysis was conducted for five studies with 11 effect sizes, as shown in Table 5. As revealed in previous research (Mayer, 2005; 2014), it was expected that there would be an overall difference between single and multiple representation groups. Results of the meta-analysis, displayed in Table 4, revealed a significant effect size, r=.48, CI_{95}[.25-.65], k=11, p<.001. This is in line with previous research, confirming that multiple representations that explain for one another and are designed for instructional purposes are better for overall learning than single representations (Mayer, 2014).

Meta-analysis of low-level knowledge effect sizes

There were five studies with six effect sizes utilized in this analysis. It was expected that there would be an effect on low-level knowledge. Results of the meta-analysis were significant, r=.45, CI_{95}[.25-.61], k=6, p<.001. This result mirrors results of prior research, confirming that there is a difference between single and multiple representations in terms of learning low-level knowledge (Mayer, 2014).

Meta-analysis of high-level knowledge effect sizes

There were three studies with five effect sizes utilized in this analysis. It was expected that there would be a significant effect on high-level knowledge. Results of the meta-analysis did not reveal a significant effect, r=.5, CI_{95}[-.02-.81], k=5, p=.06. These results are in line with Reinwein and Huberdeau (1998), whose meta-analysis on single vs. multiple representations using Dwyer and colleagues studies found that there was not a difference in high-level knowledge. However, there was a large effect, which is in line with Mayer and colleagues research who found a large effect size for transfer (Butcher, 2014). Explanations for these results are further examined in the *Discussion* section of this paper.

Table 4

Random effects models for all effect sizes, high-level knowledge effect sizes, and low-level knowledge effect sizes

Group	mean *r*	lower *r*	upper *r*	z	p	k	X^2	df	p	I^2	Rosenthal's fail-safe *N*
All	.48	.25	.65	3.85	.00	11	12.11	11	.278	9	498
High	.5	-.02	.81	1.90	.06	5	4.38	4	.357	8	99
Low	.45	.25	.61	4.1	.00	6	6.13	5	.293	18	147

*p<.05 for significance
*I^2 levels were below 25% which indicates a low level of heterogeneity
*Fisher's Transformation was built into the test

Discussion

Are multiple representations better for learning than single representations in computer-based training?

When comparing multiple vs. single representations in a CBT environment, there was a significant difference ($p<.001$) with a medium-high effect ($r=.48$) (Cohen, 1998). Participants scored an average of 13% higher on post-tests in the multiple representation format. This finding is in line with current research on dual-coding and the multimedia principle, showing that multiple representations are better for learning (Mayer, 2001; 2005; 2009; 2014). Therefore, utilizing a combination of verbal and visual representations that explain for one another should improve learning in a computer-based environment (when following good design practices). This finding also coincides with Pastore (2014), who found that learners preferred multiple over single representations. Thus, including multiple representations can improve learner achievement and increase learner satisfaction. It is recommended that instructional designers take this into consideration when developing computer-based instruction.

Are multiple representations better than single representations for learning low-level knowledge in a computer-based training environment?

The effects of multiple vs. single representations on low-level knowledge in CBT revealed a significant difference ($p<.001$) and a medium-high effect ($r=.45$) (Cohen, 1998). Participants scored an average of 13% higher on post-tests in the multiple representation format. This finding is in line with current research on the multimedia principle (Mayer, 2001; 2005; 2009; 2014). As a result, developing computer-based instruction will benefit learners when the instructional purpose is to teach rote knowledge (low-level).

Are multiple representations better than single representations for learning high-level knowledge in a computer-based training environment?

The effect of multiple vs. single representations on high-level knowledge in CBT was not significant ($p=.06$) but had a high effect ($r=.5$) (Cohen, 1998). Participants scored an average of 10% higher on post-tests in the multiple representation format. The non-significant finding contradicts findings by Mayer and colleagues (2014), yet agrees with their conclusion that the effect size would be strong. The most plausible explanation for this finding is that there are not enough studies to achieve statistical significance (Stevens, 1996). This meta-analysis specifically targeted computer-based instruction using static images with adult learners in order to make recommendations to instructional designers in higher education and corporate settings. Given the popularity of CBT, the amount of money spent on CBT each year, and the role that the multimedia principle has on CBT design, the dearth of studies was very surprising.

Additionally, it is well known that a limitation of meta-analysis is that studies with weak methodologies are analyzed along with studies that have strong methodologies, which can impact results (Brewer, 2009). A number of studies (See Table 5) used in this analysis did not report reliability data (2 of 5) and/or did not discuss content validity (3 of 5). In fact, only one of the studies used both. Thus, there was no evidence that the content of the test was really tested, that the content was correct, or that the test items were correct for a majority of the studies utilized. As a result, it is recommended that more experimental research on the multimedia principle in CBT in conducted, which takes these methodological recommendations into consideration. Additional studies would help to clarify the effect that multiple representations have on learning in a computer-based environment for meaningful (high-level) knowledge and give designers the ability to better justify multiple external representations (MERs) in the design and development process.

Table 5
Studies used in meta-analysis

Study	Groups	Test	Reli-ability	Validity of content	M	SD	ES (r)	Total Questions	*n*	%
Cuevas, H., Fiore, S., & Oser, R. (2002).	Text	High – Meaningful Learning	No	Yes	0.43	0.27	0.21	10	30	43
	Text+Image				0.54	0.24			31	54
	Text	Low – Rote Learning	No	Yes	0.58	0.21	0.13	20	30	58
	Text+Image				0.63	0.18			31	63
Pastore, R. (2010).	Audio	Low – Rote Learning	Yes	Yes	9.68	3.82	0.46	20	38	48
	Audio+Image				13.74	3.91			38	69
	Audio	High – Meaningful Learning	Yes	Yes	8.63	3.91	0.03	20	38	43
	Audio+Image				8.89	3.44			38	44
Sung, E., & Mayer, R. (2012).	Text	Low – Rote Learning	No	No	7.9	3.66	0.37	25	50	32
	Text+Image				11.08	4.25			50	44
Eitel, A., Scheiter, K., & Schuler, A. (2013).	Text	Low – Rote Learning	Yes	No	6.09	0.41	0.67	8	19	76
	Text+Image				6.84	0.42			19	86
	Text	High – Meaningful Learning	Yes	No	8.33	0.55	0.94	16	19	52
	Text+Image				11.67	0.56			19	73
Moreno & Valdez (2005).	Images	Low – Rote Learning	Yes	No	2.5	2.07	0.74	6	16	13
	Text+Image				9.21	3.69		6	19	48
	Text	Low – Rote Learning	Yes	No	7.8	3.32	0.19	6	15	41
	Text+Image				9.21	3.69		6	19	48
	images	High – Meaningful Learning	Yes	No	2.12	1.63	0.51	4	16	n/a
	Text+Image				4.42	2.19		4	19	n/a
	Text	High – Meaningful Learning	Yes	No	3.4	1.72	0.25	4	15	n/a
	Text+Image				4.42	2.19		4	19	n/a

*'%' indicates the percentage out of 100%
*'Yes' in the reliability and validity columns means it was included. 'No' indicates it was not.

Conclusion

This meta-analysis sought to examine the effects of the multimedia principle on CBT, specifically looking at this principle's effects on different levels of learning (low-rote and high-meaningful knowledge). Results of the meta-analysis revealed that overall there is a difference in achievement when learners are presented with single vs. multiple representations that explain for one another. Looking at the average percentages on achievement tests, the multimedia principle improved low-level knowledge by 13% and high-level knowledge by 10%.

In practice, instructional designers use a variety of theories to develop their instruction, including dual-coding theory, the multimedia principle, learning styles, etc. Sometimes they are not using a theory at all, but instead are relying on experience. Some instructional designers are research-based and others are not. The reasons for this are beyond the scope of this paper. However, the revelations in this analysis are very important to designers and need to be taken into consideration by both practitioners in the field and in the research community. These findings can help designers decide if the return on investment (ROI) of developing multiple representations is worth it for each project and learning objective.

Prior research has revealed that images used for learning must explain for the verbal representation (text/narration), otherwise the images will actually hinder the learning process (Schnotz & Bannert, 2003). Thus, designers will need to decide if the effects found in this study and the average 10-13% gain in achievement is a large enough ROI for designers to develop both high-quality graphics and text for computer-based instruction. Additionally, Pastore (2014) found that learners prefer multiple representations to single representations for learning, and that they prefer colorful, detailed graphics. As confirmed by the analysis, there is an improvement in learning when multiple representations are used. However, developing high-quality graphics takes time and can require a graphic designer and/or computer programmer. Is the cost worth the improvement?

The most surprising finding in this analysis was that there were such a limited number of studies on the multimedia principle in a CBT environment with adult learners. Therefore, it is recommended that more studies examine this topic. These future studies must demonstrate that the content and assessment items used in the experiments are instructionally sound. They also need to test both high- and low-level knowledge. If designers are going to spend money and time developing graphics for instruction in CBT, there must be a significant body of work to help quantify the ROI.

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Editor's Note: In the early 1960s, we discussed *self-instruction* and *teaching machines*. Today we use computers, networks, and courseware with hyperlinks for interactive learning. The unknown variable is how much human assistance is needed to achieve the desired learning outcomes. A course on how to write computer programs is used for this study.

Supervised learning and online education:
the challenges associated with programming education environment

Belle Selene Xia and Elia Liitiäinen
Finland

Abstract

Previous research has confirmed the benefits of online learning in programming education. While the potential of a web-based learning environment and advanced algorithm simulation tools in computing education have been acknowledged by the scientific community, we have chosen to discuss the challenges of online learning, especially for novice students in programming education. A statistical analysis of learning outcomes was performed on students who participated to both an online and a supervised learning environment in order to quantify the effect on student performance in the exam. The respective teaching strategies and educational approaches included customisation of learning experiences in response to the challenges faced by students in programming education. Results confirmed that some challenges associated with programming courses, such as a high non-completion rate and barriers to interaction, are reflected in student performance. It was concluded that students perform better in the exam when they are allowed to submit their work to the algorithm simulation exercises after full consideration. Students who excel at supervised exercises benefit the most from the online unsupervised exercises. In terms of future research, educational approaches to programming education from the students' perspective deserves further analysis.

Keywords: computing education, student learning, teaching, educational technology, educational evaluation.

Introduction

Technological development has had a strong impact on learning. Universities have responded to technology trends by adopting increasing amounts of information and communication technologies as well as mobile technologies in programming education. In a web-based learning environment, the responsibilities of learning have shifted from the course instructor to students in self-organised studies. The course instructor is then given more organisational responsibilities in the form of quality teaching and communication. Given the distinctive nature of online learning and learning in a traditional classroom setting, the depth of interaction in online courses pose a serious challenge to student learning, which is reflected in student behaviour and performance in the exam. Previous research also confirmed that programming courses emphasising extensive online assignments suffer from a high non-completion rate. (Winslow, 1996)

While there exist various benefits of organising introductory programming courses using advanced simulation tools and technological solutions, this kind of arrangement also invites costs. Therefore, the drawbacks of a web-based learning environment deserve further analysis. Given that one of the main challenges with learning in such an environment is the depth of interaction between the course instructor and the students, previous research proposed different solutions, such as integrating social and emotional communication systems, including instructional videos and discussion forums, to educational practices in response to these challenges. However, with regard to the success of these learning resources, research has shown mixed results. (Warren et al., 2013) Consequently, not all education institutions are convinced about the use of online exercises as the main source of teaching in introductory programming courses.

Background

Using a web-based learning environment in programming education enables algorithm simulation exercises in which students get to learn programming concepts and practice their programming skills related to data structures, priority queues, hashing methods and sorting algorithms in a virtual environment. The student manipulates data structures and the resulting changes in the structures, which are visualised as conceptual diagrams in the forms of nodes, references and arrays. The algorithm simulation exercises constitute the core of the introductory programming course. Specifically, the students get to visualise the simulation of algorithms and data structures via a user interface. The students also get to modify the data structures during the learning process by submitting answers to the course database and receive immediate feedback. The purpose of these exercises is to support students to learn the functionality of data structures and algorithms. In these algorithm simulation exercises, students simulate a given algorithm with given input data structures. The students can solve the algorithm exercises by giving a conceptual diagram that depicts the states of the data structures during and after execution.

The web-based learning environment acts as an online submission system and offers simulation exercises with data where students get to solve different instances of the same exercise set. The exercise can be solved by manipulating the programming operations via user interface. That is, students get to drag and drop key and nodes by applying exercise-dependent push buttons. The simulation sequence is then recorded. The automatic assessment system provides immediate feedback by showing the correct simulation steps after which a new exercise instance is given. Ben-Ari (2001) introduced the concept of bricolage where students try to pass the simulation exercises via trial-and-error. This was inefficient, which hinders student learning. The automatic assessment system also provides model solutions via means of algorithm simulation and allows students the option to resubmit solutions to a given exercise. However, Mitrovic et al. (2000) found that if partial or full model solutions are provided to students, they perform less well than those who receive only hints for finding solutions. System-recorded data on student behaviour during the exercise session, such as submission rate and time spent on the task, was used to study the efficiency of these automatic assessment systems on the learning outcomes of students.

Problems experienced by novice in programming education

In addition to the difficulties in learning programming, programming courses are further challenged by the high drop-out rates and the duration of time that is needed to turn a novice to an expert programmer. (Winslow, 1996) Teaching beginners to program is difficult, as these students seem to lack detailed mental models and fail to apply programming knowledge in a meaningful way. The gap between the novice and the expert programmers in understanding programming constructs is attributed to shortcomings of code-planning and errors in their prior knowledge of programming. As a matter of fact, novice and expert programmers use different strategies to understand programs that are conventionally or unusually structured. Specifically, expert programmers tend to employ a top-down conceptually driven strategy when reading conventional programs and a bottom-up heuristic strategy when reading unconventional programs. (Widowski & Eyferth, 1986) In addition, experts can retrieve relevant plans from memory and then generate code from initiation to calculation to output whereas the novice must create plans by reasoning backwards from calculations to the elements around it.

Concepts that occur in many cognitive theories such as schemas, working memory, semantic networks and mental models are difficult concepts for the novice students to grasp. Additional challenges for beginners include general orientation, the notional machine, notation, structures and pragmatics of programming. Specifically, the knowledge of what the program does and what to do with them; understanding the role of the computer as a system that executes programs; learning the syntax of a particular programming language; and skills of planning, testing and debugging programs are all unfamiliar to the novice students. (Du Boulay, 1989) The matter is further complicated by the fact that developing knowledge of programming involves a high load of cognitive capacity. Even at the level of computer literacy, it requires the construction of mental representations and the structuring of operations to schemas, which are all found to be challenging for the novice programmers (Rogalski & Samurcay, 1990)

Winslow (1996) has shown that being able to write a program has little relation with the ability to read the program. That is, we need to make distinction between program comprehension and program generation. This has important implications for course design and assessment tools to support student learning. Novice students seem lack knowledge in acquiring the necessary programming information and how to combine individual statements into valid programs. (Perkins & Martin, 1986) Given that students' background, abilities and the levels of motivation predict different performance, yet research results show that introductory programming course has a vital effect in supporting novice students learning programming, which sets the learning and teaching of programming at the centre of an extensive educational literature. Linn and Dalbey (1989) established that teaching influences the learning outcomes of students and affect their design and problem-solving skills. Current theory suggests that the focus should not be merely on instructor teaching but on student learning. That is, scholars are interested to know the effect of different teaching methods on the student involvement in the course as well as their performance during the course, which confirms the importance of our research. (Robins et al., 2003)

Challenges of online learning in programming education

Ivica et al. (2009) has confirmed that technological advancement has resulted in an increasing integration of technology to higher education. Heckel et al. (2012) suggested the main advantages of online learning in programming education is offering an alternative mode of learning that saves space costs. However, the integration of technology into teaching also invites costs. Ivica et al. (2009) have mentioned the costs associated with coding a web-based learning environment in higher education. Kizilcec et al. (2013), on the other hand, found that one of the key challenges associated with online learning lies in the course completion rates of students.

Seaton et al. (2013) collected extensive data on student learning behaviour in an online forum. The introduction of information and communication technologies in higher education has reshaped the learning approach in programming education. In both online learning and traditional classroom learning, the teaching goals, course activities and assessment methods are planned in advance. When compared to the traditional classroom learning environment, the level of interaction between the students and the course instructor varies and this results in different learning outcomes. Given the differences in the level of interaction between these environments, this is acknowledged to be a huge challenge in teaching using online learning resources.

Esteves et al. (2009) acknowledged the difficulties of learning programming for beginners, as understanding the core of programming requires extensive problem solving skills and student commitment. The challenges associated with programming education come both from learning and teaching. Smith et al (2009) suggested that incorporating new forms of technology in science learning is critical in providing innovative learning experiences. However, the greatest challenge lies in how to make these learning experiences work in practice. Allen and Seaman (2013) found that 2.6% of higher education institutions are using online courses in their teaching and another 9.4% report of planning to use open online courses in higher education. While online pedagogy has high potential, many education institutions still question the sustainability of these online solutions in introductory courses, such as in programming courses. Despite the significance of information and communication technologies and web 2.0 applications in educational contexts, Dreher et al. (2009) suggested that there exist considerable pedagogical challenges associated with using ICT technologies in information system education. Sampson and Karaglannidis (2002) have added challenges associated with online learning such as the barriers of time and distance and customisation of learning experiences. Chatti et al. (2010) confirmed that technology-enhanced learning requires extensive preparation and that the success of technology-enhanced learning is unclear.

Implications of online learning on teaching

McAuley et al. (2010) defined e-learning to be an online phenomenon integrating the connectivity of social networking under the facilitation of an acknowledged expert in the given field of study. In distance learning, the students get to self-organise their studies according to their learning goals, prior knowledge and interests. In both e-learning and distance learning, information and communication technologies can be used in juxtaposition with social media technologies in teaching. Some universities have also integrated mobile technologies to web-based technologies in teaching students programming knowledge. The role of the course instructor in such a learning environment is to prioritise important ideas and concepts as well as organise learning resources to help students to learn. The course instructor is also responsible for motivating the course participants to engage in the learning process, monitoring group discussions and supervising the entire learning process, and thus have a vital impact on the success of online courses.

Programming courses using online assignments may address the interaction element of learning in terms of design, content and platform features, which have an important effect on the student engagement process. The psychological factors that affect learning outcomes in programming education environments include motivation, learning attitudes and expectations of the course participants. Jadin et al. (2009) confirmed that learning outcomes in programming education are significantly affected by the learners' motivation and engagement. Online learning is most suitable for students who desire alternative learning environments where technology plays a vital part. Walker and Fraser (2005) suggested that in distance learning, advanced programming tools are found to support students to learn programming skills. These tools eliminate data transfer errors adding to the overall validity of technology in higher education. In addition, Harris (2013) has shown that common learning tools used to support online learning include, for example, instructional videos, peer assessment of assignments, standard quiz, survey tools and discussion forums. Muratet et al. (2009) found game software increases students' motivation to learn programming. The authors have shown in their research that gaming features can be introduced in computer science to enhance students' learning of programming skills.

Methodology

This paper seeks to address the issues that arise when teaching introductory computer science programming course online as opposed to face-to-face. The research questions in this study from the students' perspective are formulated as follows:

1. What are the challenges of learning programming from the novice students' point of view?
2. What are the challenges of online learning in programming education?
3. How are the challenges of online learning reflected in the student performance as measured by grades?

Objectives

Education research in computer science has recently focused on the topics of e-learning, online learning and distance learning as a result of technological advancement in higher education (McAuley et al., 2010). Previous research has bought the benefits of technology integration in introductory programming courses. Research has also confirmed that the potential of using technology in teaching is under-actualised (Gillet et al., 2009). However, technology and online learning in programming education also invite costs and challenges. In this study, we will discuss the challenges of online learning in introductory programming courses along with proposed solutions. Specifically, we will assess the learning outcomes and student experience in introductory programming courses using online exercises and confirm the challenges associated with distance learning and self-organised studies in programming education.

Despite the extensive research on the subject matter and numerous papers on discussing the benefits of online learning in programming education, one of the questions raised with using technology in teaching is how to make it work in practice. In this study, our research problem is formulated as follows: *how do online exercises in introductory programming courses support learning in terms of student performance as measured by grades?* The aim of this research is to evaluate the success of online learning in the programming courses from the student point of view in an empirical study. Blikstein (2011) has described a method to visualise students learning programming. The author has approached the research question via a programming assignment and analysed the programming experience using quantitative methods, which laid a foundation for our research. Subsequently, this paper is organised as follows. We have gone through the literature review on the challenges of online learning in programming education. Next, we will introduce the data and methods used in this study. Finally, we will summarise the results of our study and discuss their impacts on teaching in the discussion and conclusion section of this paper.

Subject

The data in our study is consisted of exercise and exam results of an introductory programming course ,for computer science students on data structures and algorithms, during the years 2008, 2009, 2010 and 2012. The course requirement consisted of the following arrangement: online exercises without supervision, exercise sessions with a possibility for assistant supervision and a final course exam. All three parts must be passed in order to complete the course. In this study, we used the average submission rate, expressed by the ratios of the total number of submissions to the total number of exercises, in our calculations. Students who failed to complete the exercises or attend the exam were not included in the analysis. The percentage of students belonging to such a group from the total number of course participants is reported in Table 1. (see p. 24)

Procedure

Conditional on passing the other obligatory requirements of the course, the students may attend the course examination at the end of the course, which is graded on a scale from 0 to 5. In the final course grade, both the online and supervised exercises are similarly graded and taken into account in a weighted average. In order to analyse the effect of two different types of exercises on student performance in the course exam, we have first divided the students into four groups. The groups are formed by considering students with grade between 1 and 4 in the supervised and online exercises as one group; students with grade 5 in the supervised exercises and grade 1-4 in online exercises as the second group and so on. By describing the groups as pairs (x,y) with $x,y \in \{0,1\}$, we observe that (0,0) is consisted of students not achieving top marks in neither exercise type whereas in (1,1) the students have scored the maximal grade in both.

In Table 2 (see p. 25) we have performed a formal analysis of the grade distribution. In this case, the grades are divided into three classes corresponding to 1 - 2 (pass), 3-4 (good) and 5 being excellent. Since both the online and supervised exercises are classified, the students are divided into nine classes based on their grades in the respective exercises. For these classes, the mean exam grades together with the 95%-confidence intervals are described. Moreover, in Table 2 for any cell in row i and column j ($i > 1$), we have tested if $m_{i,j} > m_{i-1,j}$ for cell means $m_{i,j}$ using the Welch's test.

The regression estimation used in our analysis specifies the nature of the relationship between a set of variables including the effect of the independent variables on the dependent variable. In this study, the dependent variable is exam grade and the independent variables are exercise points, submission rates and year, as shown in Table 5 (see p. 26). The results of Table 5 allows us to check and ensure that these are indeed the variables of our analysis. The results of the regression, given the value of the independent variable, can be used to predict the value of the dependent variable. We will also perform a correlation analysis in conjunction to our regression model to see if the assumptions of the estimation model have been met. Table 6 (see p. 26) gives us the model summary part of the output. The information given in Table 6 is important in especially multiple regression analysis. The value of R is the multiple correlation coefficient and tells us how strongly the relation is between the dependent variable and the independent variable. R square in this case is the coefficient of determination.

The output from our correlation analysis is organised differently than the output obtained from the normal correlation procedure. Specifically, the first row of Table 4 (see page 26) describes the correlation between the dependent and the independent variables. The correlation of the variable with itself is 1. The next row in Table 4 describes the significance of the correlation coefficients. As it is unlikely that the correlation coefficients would give us such large values unless there exist linear relation between these given variables, this confirms to the assumption of our regression estimation. Finally, the last row of Table 4 describes the number of observations for all of the variables under analysis plus the number of observations that have values for both the dependent and the independent variables.

Results

The distribution of the exam results in the four groups is shown in Figure 1.

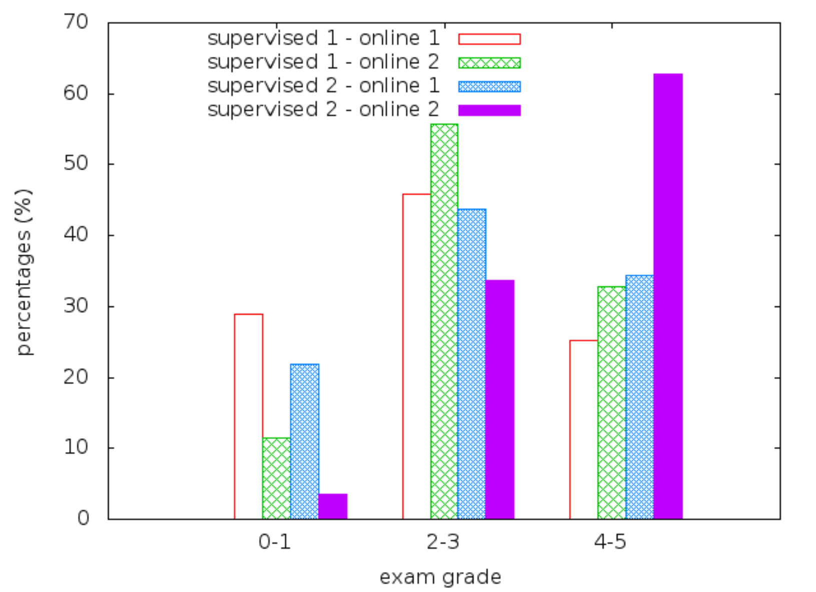

***Figure 1.* Distribution of exam grades conditionally on exercise results**
where 0 indicates exercise result being in the range 1-4 and 1 indicates 5

1. supervised 1 - online 1 represents students who got grades from 1 to 4 from the exercises;
2. supervised 1 - online 2 represents students who got grades from 1 to 4 from supervised exercises, 5 from online exercises;
3. supervised 2 - online 1 represents students who got 1 to 4 from online exercises and 5 from supervised exercises;
4. supervised 2 - online 2 represents students who got 5 from both the exercises.

From Figure 1 it is seen that doing online and supervised exercises in general improves exam results. In addition, we may conjecture that students who excel at supervised exercises benefit the most from the online unsupervised exercises. Also, it can be concluded that participating in the supervised and online have different effect on the performance in the exam. Specifically, those students getting high exam grades are mostly those students who have performed well in supervised exercises.

The results in Table 1 tell us that a significant number of students have failed to pass the course exercises. In addition, we see that the failure rates are similar from year to year, and during this time period the exercise session has been conducted in an algorithm simulation environment. In this environment, the user visualises changes in the data structures via conceptual diagrams including nodes, references and arrays. The user gets to alter the data structures by dragging and dropping graphical entities, such as keys, nodes and references via a user interface. These algorithm simulation exercises where the students is requested to simulate a given algorithm with a set of input data structures are found to be too difficult for some of the students in terms of its interface, technical design and usability. This also raises the question of whether the use of such a programming tool supports student learning programming concepts, such as priority queues, binary heap, search trees and hashing methods, which can be taught in a supervised setting using traditional teaching methods.

Table 1.

Number of students who failed to complete the exercises

Year	Failed (%)
2008	40.645
2009	35.766
2010	45.872
2012	45.517

From Table 2, we observe that students who excel in both types of exercises display similar performance in the exam, as students in the cell (3, 3) achieve a high average grade. We also observe that in the third column, online exercises have a statistically significant impact when moving from pass to good and from good to excellent given that students have performed well in the supervised exercises. These observations support the conjecture that performing well in online exercises is most useful when the student also succeeds in supervised exercises. Table 2 confirms the close connection between participating in the online exercises and the supervised exercises and that using the programming tool alone is not sufficient to succeed in the exam. Moreover, improving the grade in online exercises has the largest influence on the exam grade if accompanied by an improvement in the supervised exercises, and performance improvement in online exercises is no longer statistically significant if students do not perform well in supervised exercises.

Table 2

Exam grades given exercise results.

The cell means between rows in the same column are compared using Welch's test

Online	**Supervised**		
	Pass	**Good**	**Excellent**
Pass	1.735 [1.258,2.213]	2.263 [1.516,3.010]	1.917 [1.407,2.426]
Good	2.818 [2.277,3.360] 0.003	3.094 [2.578,3.610] 0.036	3.204 [2.861,3.547] 0.001
Excellent	2.000 [0.735,3.265] 0.911	2.913 [2.310,3.516] 0.671	3.832 [3.616,4.048] 0.001

Table 3 includes the descriptive statistics of the mean, standard deviation and observation count (N) for all of our variables under analysis. In this case the year 2008 and 2009 are classified as dummy variables. The mean exam grade is 3.08, the mean exercise grade is 3.73 and the mean submission rate is 2.19. The number of students participating in the course has remained quite the same from year to year. On the other hand, the students' academic performance varies and the mean grade for this course is comparatively low, which might be due to the difficulty of the course and the allocation of learning resources. Nevertheless, those students who manage to get good exam grades are also those who have put a considerable amount of effort to the course as discussed before.

Table 3

Descriptive statistics of exam grade, exercise grade and submission rate

	Mean	Std. Deviation	N
examgrade	3,08	1,378	219
exercisegrade	3,73	1,416	219
submission	2,493625939	1,010632862	219
year2008	,3790	,48625	219
year2009	,3927	,48947	219

According to the correlation coefficients in Table 4 exam grade is positively correlated with the exercise grade as expected. However, we see that the correlation is less than 0.5, and thus not strong. The average submission rate is negatively correlated with the exam grade and the correlation effect is also not strong. The statistical significance of the year variable and the correlation between the submission rate and the exercise points shows that the correlation effect of these variables does not have a vital impact in terms of the exam grades. We conclude that the average submission rate cannot be used to predict exercise grades and exercise grade is limited in predicting exam performance. This results is also confirmed in Figure 1. Table 5 simply sums the independent and the dependent variables. Table 7 shows the ANOVA part of the output and confirms that our estimation model explains a statistically significant portion of the variability in the dependent variable from variability in the set of independent variables.

Table 4

Correlation analysis of exam grade, exercise grade and submission rate

		examgrade	exercisegrade	submission	year2008	year2009
Pearson Correlation	examgrade	1,000	,420	-,125	,038	,016
	exercisegrade	,420	1,000	,042	,049	,054
	submission	-,125	,042	1,000	,030	,025
	year2008	,038	,049	,030	1,000	-,628
	year2009	,016	,054	,025	-,628	1,000
Sig. (1-tailed)	examgrade	.	,000	,032	,288	,408
	exercisegrade	,000	.	,271	,235	,213
	submission	,032	,271	.	,330	,355
	year2008	,288	,235	,330	.	,000
	year2009	,408	,213	,355	,000	.
N	examgrade	219	219	219	219	219
	exercisegrade	219	219	219	219	219
	submission	219	219	219	219	219
	year2008	219	219	219	219	219
	year2009	219	219	219	219	219

Table 5
Variables Entered and Removed in the Analysis

Model	Variables Entered	Variables Removed	Method
1	year2009, submission, exercisegrade, year2008[b]	.	Enter

a. Dependent Variable: examgrade

b. All requested variables entered.

Table 6
Model summary and the coefficient of determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,444[a]	,197	,182	1,246

a. Predictors: (Constant), year2009, submission, exercisegrade, year2008

Table 7
Results of ANOVA analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	81,681	4	20,420	13,162	,000[b]
	Residual	332,000	214	1,551		
	Total	413,680	218			

a. Dependent Variable: examgrade

b. Predictors: (Constant), year2009, submission, exercisegrade, year2008

The coefficients given in Table 8 describe the value of the regression equation. The predicted variable is also the dependent variable. The slope of the estimation model is the intersection of the line labelled with the independent variable and the column labelled B. The results from the regression estimation confirm our previous analysis. We see that doing exercises is beneficial for the exam but the exercise grade cannot be used to directly predict the level of student performance in the exam. In addition, repeated submission is often associated with the difficulty of the exercises, and thus students who find the exercises to be difficult also finds the exam to be difficult as well and random submissions are found to affect the exam grades negatively. These phenomena are independent of the course years. We conclude that learning programming especially the concepts of algorithms require support from the course instructors and an active level of interaction between the students and the lecturer.

Table 8
Results of regression estimation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,979	,332		5,968	,000
	exercisegrade	,412	,060	,423	6,861	,000
	submission	-,197	,084	-,144	-2,352	,020
	year2008	,091	,225	,032	,405	,686
	year2009	,047	,223	,017	,211	,833

a. Dependent Variable: examgrade

Discussion

Billington and Fronmueller (2013) have summed the challenges of online learning in terms of grading, monitoring, course credit and interaction. Specifically, the challenge associated with the course monitoring is especially evident in programming courses using online assignments. Daradoumis et al. (2013) have stated that the key challenges of online courses involves a low level of teaching involvement, the heterogeneity of learners, high drop-out rates, limitations associated with the learning analytics and automatic assessment. Siemens (2013) has confirmed that the drop-out rates and sustainability are pressing issues in courses offering online learning. In this study, we have found that these challenges associated with introductory programming courses using online web-based learning environment are empirically reflected in the student performance and learning outcomes.

In order to better understand the difference in the learning outcomes of students participating in a web-based learning environment and a traditional classroom setting, Billington and Fronmueller (2013) has differentiated the interaction between instructors and learners and between learners. The interaction between learners in a web-based learning environment can be enhanced via means such as discussion forums, study groups and course wikis in both the official courseware and in unofficial course settings. In terms of the interaction between the instructor and learners, Tomkin and Charlevoix (2014) has studied the effect of the instructor involvement in the discussion forums in an online courses. Their research results show that the instructor involvement had no statistically significant impact on the course completion rate, participation rates and general satisfaction of the course. However, Warren et al. (2013) have suggested that the human-human interaction is critical but limited in online learning. Many computational tools, such as unit testing, are found to be difficult to use for novice students, and thus human-machine interaction cannot substitute human-human interaction, which is a prerequisite for attaining a meaningful learning experience based on social engagement. This result is also confirmed by our research.

It is acknowledged that start-up capital is required to integrate technology to teaching. This cost is covered either by the educational institution or by the course participants. In the latter case, examples of such an arrangement can be seen in edX (courses in their Xseries) and Coursera (Signature Track courses). Udacity also enables video chat via webcam as means to enhance interaction and help the students to learn and where the student's identity is checked during the first interview. Coursera, on the other hand, collects a type sample of keystroke 'fingerprint' for each submission of the graded exercises. Peer grading and automatic grading are often used in these courses as means to minimise costs associated with grading assignments and enhance the level of interaction between the participants. Warren et al. (2013) have shown that in introductory programming courses human interaction can be increased via peer feedback in online learning, as students found examining their peers' code to be helpful. The feature of peer grading was not used in the introductory programming course of our analysis but instead automatic grading was used.

Future work

In terms of future research we need further analysis to understand the relationship between exercise points and exam grade in programming courses that use online learning. The understanding of the teaching and learning process in programming courses opens a potential avenue for tailoring personalised learning experience for the students, as there is an increasing need to shift to a more open and learner-oriented model of learning in a personalised learning environment delivering just-in-time, on-demand knowledge experiences to the students using custom learning features. It would be interesting to analyse the specific features of a personalised learning environment that support learning outcomes where students’ needs and learning preferences are taking into account during the engagement process. The goal is to increase students' motivation and engagement during the learning process. Gillet et al. (2009) have investigated both the formal and informal requirements for personal learning environments given the students' personal and social learning preferences. The authors conclude that the potential of global web 2.0 educational service bundles and information learning communities are currently under used, and thus offer new opportunities for further research.

Conclusion

In this study, we reported the results of statistical analysis derived from data gathered from studying the behaviour of students who participated in an introductory programming course that uses automatically assessed algorithm simulation exercises. The students are allowed to resubmit their solutions to a single assignment after their previous submissions are graded, and these submissions rates are used in this study to determine their correlation with exam grades. Our results show that students perform better in the exam when they are allowed to submit their work but that the average submission rate is kept low, as careless submissions in the case of full consideration affect the exam performance negatively. In addition, we found that based on the submission rate it is not possible to predict the exercise points, and thus the causality relationship between the average submission rate and the exercise points cannot be established. Having the options of online unsupervised exercises and supervised exercises have different effect on student learning, which is reflected in their exam performance. We conclude that online exercises cannot substitute for supervised exercises where the course assistants are present to support student learning.

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Editor's Note: Microteaching uses television for feedback to student-teachers for self-evaluation, and optionally for discussion and evaluation with fellow students, teacher-trainers and researchers.

Impact of microteaching video feedback on student-teachers' performance in the actual teaching practice classroom

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Abstract

This study investigated the Impact of Microteaching Video Feedback on Student-Teachers' Performance in the Actual Teaching practice classroom. The study was set to achieve three objectives; three research questions and three hypotheses were formulated to guide the study using a quasi-experimental pretest-posttest control group design. One hundred and fifty (150) student teachers were purposively selected as samples. Mean score and standard deviation were used to answer the research questions and t test was used to test the null hypotheses at $p \leq 0.05$ level of significance. The study revealed that student teachers who were exposed to microteaching video feedback performed better in teaching practice than those that were not exposed to it. It was concluded that student teachers perform effectively well in the classroom when exposed to self-assessment through microteaching video feedback. It is therefore recommended that the use of video feedback microteaching be emphasized in the conduct and evaluation of microteaching in colleges of education.

Introduction

Microteaching was one of the most recent innovations introduced by Allen in 1963 at Stanford University with the aim of modifying teacher's behavior and enhancing performance in the classroom. Microteaching serves as a meeting point between theory and practice for training of teachers. Ike (2003) believes that microteaching was developed as an answer to the question of how best teachers are prepared for the teaching profession. It is when student teachers acquire the necessary skills through microteaching that they are posted to various schools for teaching practice. Students used video feedback to evaluate their own microteaching performance. Peers viewed the video feedback and recorded their evaluations of the lesson using checklist, comments and critiques.

Researchers like Kpanja (2001) supported the notion that effective video feedback in microteaching worked for teacher education. The video not only reflects the student performance, it provides an avenue of evaluation of student teaching in the classroom. This technology supported the strategy of doing, reviewing and doing again that seemed effective in improving teacher performance (Jurich, 2008).

Despite the entire significant role played by microteaching in preparing students for teaching practice and eventual exposure to real classroom teaching for teachers, there has been a continued outcry about poor teaching exhibited by teachers. This is attributed to teaching methodology, techniques, attitude to work, competence and general behavior of the teacher. This poor performance of teachers in the classroom calls for questions about the efficacy of teacher education programs including microteaching for teacher training in the Nigerian educational system. Do educational institutions provide sufficient avenue for practice teaching, including microteaching and its organization and evaluation. This informs the need for investigation into the effect of microteaching and teaching practice on student-teachers in teacher education programs in Nigeria.

Objectives of the Study

Specifically the objectives of the study were to:

1. Find out the impact of microteaching video feedback on student teachers' performance in the field experience.
2. Ascertain the difference between the teaching practice performance of the student teachers exposed to video feedback and those not exposed to video feedback in microteaching.
3. Examine the difference between the teaching practice performance of male and female student teachers exposed to video feedback in microteaching.

Research Questions

The following are the questions to be addressed in the study;

1. What is the impact of microteaching video feedback on the student teachers' performance in teaching practice?
2. What is the difference between the teaching practice performances of the student teachers exposed to video feedback and those not exposed to video feedback in microteaching?
3. What is the difference between the teaching practice performances of male and female student teachers exposed to video feedback in microteaching?

Null-hypotheses

1. There is no significant difference between student teachers mean achievement scores in pretest and posttest assessment of microteaching video feedback in teaching practice.
2. There is no significant difference between the teaching practice performance of student teachers exposed to video feedback and those not expose to video feedback in microteaching.
3. There is no significant difference between the teaching practice performance of male and female student teachers exposed to video feedback in microteaching.

Literature review

Most researchers agree that microteaching is an effective method applied the pre-service and in-service stages for professional development of teachers (Allen & Ryan, 1969). It is considered as a training conceptto develop selected teaching skills under carefully controlled conditions (Cruickhank et al., 1996; Sadker & Sadker, 1972; Meier, 1968). It is also viewed as a pre-induction, booster or reinforcement involving hands-on and minds-on experiences. Others perceive microteaching as a valuable instructional tool that mediates between theory and practice (Benton-Kupper, 2001; Wahba, 1999).

There are various views on the purpose of conducting microteaching. Some researchers believe it enables student teachers to improve pedagogical skills in presentation and participation or to increase the range of behaviors (Mayhew, 1982). Others claim microteaching can create awareness among student teachers of the values, assumptions and attitudes that inform their practice. Sadiq (2011) highlights the fact that microteaching is more beneficial for pre-service teachers because they are more receptive to feedback and that microteaching encourages self-evaluation. All in all, microteaching focuses on the act of teaching which enables student teachers to test their pedagogical skills in a simulated teaching context. The need for microteaching in preparing student teachers before they embark into the real classroom situations is strongly supported by research studies. Copeland (2001) conducted a study looking into the relationship between microteaching and student teachers' classroom performance. Using a five week microteaching training program as the treatment, the author carried out a quasi-experimental study. Findings indicated the experimental group exhibited a significantly higher mean rate of occurrence of the target skills than the control group. Similarly, a study by Benton-Kupper (2001) indicated microteaching as beneficial for peers to provide constructive tips and suggestions, gain new ideas and strategies and be able to discern strengths and weaknesses in teaching. Akalin (2005) did a comparison between traditional language teaching and microteaching using 52 fourth-year students placed into control and experimental groups. A questionnaire was distributed to seek student teachers' comments on microteaching. The study found student teachers' positive attitude towards microteaching to be more effective compared to traditional teaching.

A study on microteaching was also conducted in an authentic classroom. Newlove (1969) focused on 23 junior-level education students enrolled in their first professional course where the trainees taught for 15 minutes in an 8th and 9th grade English class. Based on a questionnaire, findings of the study indicated greater respect by the trainee-teachers. It also addressed concerns by student teachers on student achievement and their microteaching functions as a technique that gives student-teachers the opportunity to analyze and assimilate different teaching approaches and styles (Hamed, 1979). Since microteaching deals with fewer variables, it also provides immediate feedback that allows discussion and critique of the lessons.

Methodology

This study was conducted using quasi-experimental design involving pretest, post-test, and control group. The target population of this study was 1247 NCE III 2014/2015 Student Teachers, who passed Microteaching courses (EDU 213 & EDU 223) and are qualified for Teaching Practice (EDU 311). Two intact classes were purposively sampled and assigned into experimental and control groups. The study adopted the Teaching Practice Assessment Form as an instrument for data collection. The student teachers were observed while teaching and the NCCE Teaching Practice Assessment Form was used to score them. This was done for both pre-test and post-test. The experimental group was exposed to video feedback before the posttest assessment.

Results

The data was analyzed using SPSS and results were presented and interpreted as tables. The discussions of the results were based on the research questions and the null hypotheses.

In this segment of analysis, mean and standard deviation were used to answer the questions raised for the study. Thus, the mean scores were compared to observe the significant effect of the treatment on the students' performance in teaching practice.

Research question 1; what is the impact of microteaching video feedback on the student teachers' performance in teaching practice?

Here the mean scores of pretest and posttest assessment were compared and higher scores were observed in the posttest assessment as illustrated below:

Table 1:
Mean scores of the pre- and post-test students' performance in teaching practice.

Variables	N	X	SD
Pretest	150	55.4133	4.6721
Posttest	150	57.0067	5.4185
Total	150		

The result in Table 1 revealed that pretest mean scores = 55.4133 is lower than posttest mean scores of 57.0067. This means that the post-test mean scores are higher than that of pre-test mean score with respect to the use of video recording in microteaching. This indicates that MicroTeaching Video FeedBack (MTVFB) has significant effect on the performance of student teachers on teaching practice.

Research Question 2: What is the difference between the teaching practice performance of the student teachers exposed to video feedback and those not exposed to video feedback in microteaching?

When the mean scores posttest result of the experimental and control groups were compared the following was observed:

Table 2:
Mean scores of post-test students' performance of experimental and control groups on microteaching video feedback

Variables	N	X	SD
Experimental G1	69	58.3200	4.56828
Control G2	81	55.6667	5.57827
Total	150		

The result in Table 2 revealed that the mean score of the experimental group (G_1= 58.3200) is higher than that of control group (G_2 = 55. 6667). This shows that microteaching video feedback used in the experimental group had positive effect on the performance of students. This indicates that MicroTeaching Video Feedback (MTVFB) has a positive effect on the performance of student teachers on teaching practice. Hence, the effectiveness of microteaching video feedback in predicting the outcomes in the actual teaching practice classroom.

Research Question 3: What is the difference between the teaching practice performances of male and female student teachers exposed to video feedback in microteaching?

When the posttest mean scores of male and female students were compared with regards to video feedback, male students have slightly higher scores than their female counterpart. However, no significant difference existed as illustrated in the following table:

Table 3:
Pretest and posttest mean scores of male and female students of experimental and controls on videotaped microteaching

Variables	N	X	SD
Male	88	57.7727	5.3471
Female	62	56.2419	5.4130
Total	150		

The result of Table 3 revealed that pretest and posttest mean achievement scores of male students (57.7727) is higher than that of female mean scores (56.2419).This means that the pretest and post-test mean scores of male students are higher than that of their female counterparts in respect to the use of microteaching video feedback. This indicates that male students improved most in terms of exposure to display skills than female. However, despite the differences, pretest and posttest results indicated that video feedback microteaching MTVFB brought about significant difference on the performance of both male and female student teachers on teaching practice.

Hypotheses testing

In this section were tested to observe significant differences, in that paired sample t test was used for the hypothesis one and independent sample t test equally used for hypotheses two and three. The results were presented as follows:

Hypothesis 1: There is no significant difference between student teachers mean achievement scores in pretest and posttest assessment of microteaching video feedback in teaching practice.

Here paired sample t test was used to compared the pretest and posttest students' performance in teaching practice where significant difference was observed as explained in the following table.

Table 4:
Paired sample t-test comparison of difference between pretest and posttest scores for experimental and control groups of microteaching video feedback in teaching practice.

Variables	N	X	SD	df	t-value	P value ($p \geq 0.05$)	Decision
Pretest-Posttest	150	-1.59333	6.56419	149	-2.973	.003	Rejected

Decision rule: $p>0.05$ accept Ho, $p<0.05$ reject Ho

Table 4 showed the t-test comparison of the pre-test scores and posttest for experimental and control groups on video recorded microteaching. The result shows significance difference $t(148) = -2.973$, $p<0.05$, which implied that the null hypothesis Ho be rejected and to conclude that the pre-test mean score was significantly different from the post-test mean score with regards to video recorded microteaching. Therefore, deduction can be made that video recorded microteaching affect the performance of pre service teachers since, the students were observed to have better achievement when exposed to treatment MTVFB.

Hypothesis 2. There is no significant difference between the teaching practice performance of student teachers exposed to video feedback and those not expose to video feedback in microteaching.

The hypothesis was tested by comparing the mean scores of the two groups. In that independent sample t- test for equality of mean was run on SPSS package 20.0 and obtained the following result as presented on table 7:

Table 5:
Independent t-test for equality of mean of experimental and control groups on microteaching video feedback.

Variables	N	X	SD	Df	t-value	P value ($p \geq 0.05$)	Decision
Male	69	58.3200	4.56828	148	-3.187	.002	Rejected
Female	81	55.6667	5.57827				
Total	150						

Decision rule: $p>0.05$ accept Ho, $p<0.05$ reject Ho

The result in Table 5 indicates the significant difference between the posttest mean scores of the experimental and control group $t(148) = -3.187$, $p<0.05$. Hence, the null hypothesis Ho is rejected. This means that there is significantly difference between the post-test mean score of experimental G_1 and control group G_2 with respect to video recorded microteaching MTVFB.

The study revealed that the major problem of microteaching is inadequate personnel and physical facilities and equipment. In that most of the supervisors were not trained as microteaching supervisors and there were no microteaching laboratories to enable the video recording of the skills displayed by the students for onward assessment.

Hypothesis 3: There is no significant difference between the teaching practice performance of male and female student teachers exposed to video feedback in microteaching.

When independent t test was used to measure the equality of mean scores of male and female students in teaching practice no discrepancy in their performance as per gender was observed as indicated in the following:

Table 6:
Independent t-test for equality of mean of male and female students of microteaching video feedback in teaching practice

Variables	N	X	SD	Df	t-value	P value (p≥0.05)	Decision
Male	88	57.7727	5.3471	148	1.718	0.88	accepted
Female	62	56.2419	5.4130				
Total	150						

Decision rule: $p>0.05$ reject Ho, $p<0.05$ accept Ho

The result (of the t-test analysis) in Table 6 shows that there was no significant difference $t(148) = 1.718$, $p>0.05$. This implies that the null hypothesis is accepted. When t-test was used to compare the post-test scores of male and female students of the experimental and control group on video recorded microteaching, the result is shows that, there was no difference between the performance mean scores of male and female students in both groups. Hence, microteaching video feedback effect on the performance male and females of experimental and control group positively without discrepancy.

Recommendations

1. Colleges of education should have as a matter of urgency a microteaching laboratory where the students could well prepare teaching skills before they are sent for teaching practice.
2. The use of video feedback should be emphasized in microteaching as it gives room for fair assessment of students' performance. Since, the student will see his/her mistake hence; accept corrections as such adjust to the much needed effective skills of teaching.
3. Student-teachers shall be accorded opportunity to take part in the assessment of their practical teaching, and thereby provide avenue for self-assessment to adjust most needed teaching skills before engaging in the actual classroom teaching.

Conclusion

This study revealed that there is much that we do not know about training teachers through this method, just as there is much we don't know about training teachers in a more conventional manner. It is hoped that every College of Education that attempts the development of specific teaching skills through micro-teaching will set up a strict adherence to proper microteaching that uses video recording. It is evident from the findings of this study that student teachers learnt from peers and from reflection on their own teaching. This learning from video feedback of microteaching has been observed as having a direct implication particularly in terms of its impact on individual teaching practice and how student teacher approach course development and delivery in the classroom.

There is also an important role for the instructors to support the student teachers to be reflective and reflexive in order that they can create their own professional knowledge and create spaces for sincere and collective self-reflection and open up in skills acquisition. It is believed that the video recorded microteaching sessions provided an opportunity for the pre service teachers to gain insights into their role as teachers, to find their own voices and to create new scripts for their work in classrooms. Gender was not significant in predicting the performance of student teachers. This indicated that male and female when treated alike could do equally well in all ramifications. The finding concluded that female students should be given equal opportunity to manifest their talents like their male counter parts in teacher training and in all works of life so as, tap from their potentialities.

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