Digital Pedagogy for Self-Paced Learning in Mathematics Education

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Abstract: This paper examined the contribution of digital pedagogy (DP) to self-paced learning in higher mathematics education. The research question was: In what ways does DP contribute to a resourceful learning environment to address individual learning styles and preferences in higher mathematics education? The study used a quantitative approach, employing a critical Action Research design with pretest and posttest measures. The study participants were 126 third-semester students taking a Differential Geometry course in 2017. The tool used was the self-paced learning (SPL) index survey questionnaire. Based on analysis and discussion with relevant literature, this paper highlights the benefits of digital pedagogy, including the promotion of 21st-century skills, the provision of anytime and anywhere learning opportunities, and the creation of an e-resource repository to ensure SPL. Moreover, digital pedagogy provides adaptive learning experiences that can be adjusted to each student's learning pace and style, enabling them to learn effectively and achieve their full potential.

Key Keywords: *Digital Pedagogy, Self-Pace Learning, Mathematics Education, Nepal*

Introduction

Mathematics education is critical to student's academic development, providing them with essential problem-solving skills and logical reasoning abilities. It is a common belief that mathematics can be taught to all students, but the race and pace may vary. This belief highlights the importance of acknowledging and embracing the diversity of learners' backgrounds and learning styles in mathematics education. Therefore, there is an urgent need to address self-paced learning in mathematics education to improve student engagement, motivation, and overall academic success.

The use of technology in education can aid self-paced learning by providing students with access to resources and personalized learning experiences. A study by AlZoubi and Aburezeq (2017) found that incorporating technology into mathematics education enabled self-paced learning and improved student motivation, engagement, and performance. Technology use is an increasingly growing concern in mathematics education. The Handbook of International

Research in Mathematics Education (English, 2002), Handbook of Research on Mathematics Teaching and Learning (Grouws, 1992; Lester, 2007), International Handbook of Mathematics Education (Bishop et al., 1997; Clements, 2013), Handbook of Research on Educational Technology Integration and Active Learning (Jared, 2015), all have written in one way or another that technology uses is essential to enhance students self-paced learning. There are various ways, modes, and forms to use technology for self-paced learning. For example, pedagogy-related technology, subject-specific technology, communication-related technology, and assessment-related technology. These include computer technology, internet technology, and web technology. The mode of these technology includes offline mode, online mode, and hybrid mode. Among them, Moodle is one of the most used pedagogy-related digital tools.

Moodle is a free educational web application designed for virtual learning (http://moodle.org). It is a Learning Management System (LMS) like Blackboard, Fronter, and others to host Virtual Learning Environment (VLE) to bridge the wall between on-campus and off-campus teaching-learning activities. Moodle as LMS is based on a constructivist and social constructionist approach to education. It can provide greater mode and flexibility with respect to location and timing for students learning. Some of the scenes are as follows.

1. University mathematics educators rarely seem to take care of students' individual differences, learning preferences, and styles. What they do primarily is 'lecture in the classroom', then "good" students would learn, and "poor" ones may not. There is less provision granted in a learning opportunity for good students to excel in their learning and poor students to acquire fundamentals of learning. Educational activities are based on one-way lecturer cum syllabus dissemination within scheduled and a limited amount of F2F contact hours. We, as teachers, put less emphasis on individual learning preferences and style, learner engagement and interaction, recursive feedback and support, and interactive and dynamic formative assessment.
2. Higher education in Nepal is largely dominated by classroom lectures. Less interest is paid for engaged and interactive classrooms. Due to geographical diversity in the country, several students have grown up in remote and village areas and show introverted and shy-type psychology in the classroom. They expect to hear more from the teacher and speak less themselves. In this circumstance, classroom lectures dominated the traditional art of pedagogy within a limited amount of F2F contact hours is, also making the pedagogy less engaged and less interactive. Therefore, a problem is traced to provide an opportunity

for students to get in the learning opportunity wherever and whenever the students are interested.

In addition, in line with my professional practice, it is important to explore and share a pleasing way of doing/knowing/teaching mathematics using mathematics-specific technology as content tools in the virtual learning environment to enhance SPL. Considering of all of these problems in a basket, DP is proposed hereafter as an integrated way to experiment in higher mathematics for SPL. The research question of the study is: In what ways does DP contribute toward a resourceful learning environment to address individual learning styles and preferences in higher mathematics education? Therefore, this inquiry begins to use Digital Pedagogy (DP) for Self-Paced Learning (SPL) in higher mathematics education.

Conceptual Framework

In this study, Digital Pedagogy (DP) is conceptualized as a planned pedagogical activity integrating ICT and 21st-century skills together to enhance SPL. Within this framework, DP consists of core pedagogical activities that use VLE with seven pedagogical principles: 1) Learning Contents/Curriculum Mapping, 2) Setting Learning Outcomes, 3) Selecting and organizing Learning Resources, 4) Designing Learning Activities/Assignments, 5) Ensuring Learning Communication/Interaction/Discussion, 6) Learning Feedback/Support, and 7) Learning Assessment/Evaluation.

There is a proverb thata teaching is a mass phenomenon, but learning is an individualized experience. This study emphasized learning as self-paced activity which accounts for individualized, differentiated, and personalized learning. In this study, individualized instruction deals with learner’s pace, and differentiated instruction captures learner preference and style, and personalized learning manifests the learner's voice and choice. Therefore, this study focuses SPL (self-paced learning) as a learning situation where learners control his/her learning pace, learning preferences and style, and learner’s personal voice and choice in the learning journey.

Students have different learning preferences and styles (Gardener, 1983). The higher attention to students' individual interests and needs are growing concerns in mathematics education (Dinkmeyer, 1969). A number of researchers have advocated similar assumptions, for example: Fleming (2006), Dunn & Griggs(2000), Felder-Silverman (1988), Kolb (1984), and Honey and Murnford (1982). Honey and Mumford (1982) described four types of learners based on:

activists (learn from actions), reflectors (learn from reflective observation), theorists (learn from exploring associations and interrelationships), and pragmatics (learn from doing or trying things). Based on these various learning preferences and styles, I identified some of them as ordered read/ write (calculation), reflection (listening and watching), and experimentation (applets and artifacts) as three sources of learning preferences. Therefore, I have categorized these three learning preferences are Text, Media, and Technology (TMT) in this paper. I have used digital documents within text-based learning resources; media-based resources, images, audio, and video are used within media-based learning resources; and dynamic and interactive resources are used within technology-based resources.

This TMT learning style alignes within Felder and Silverman's (1988) model. Based on Felder and Silverman's framework, three levels of learning style are proposed in relation to the virtual learning environment. These three styles are Verbal, Visual, and Interactive. Verbal learners are those students who prefer text-based resources to analyze and internalize math content. Visual learners as those who prefer image and visual-based thinking. The interactive learner is those who prefer interactive, simulated, and dynamic learning resources to construct mathematical dynamics.

Methods and Materials

This study is carried out to analyze the effectiveness of DP in higher mathematics education to analyze “In what ways DP contribute resourceful learning environment to address individual learning style and preferences in higher mathematics education?”. I inquire about the pragmatic paradigm in this study because it deals with constructed reality. Creswell mentioned that this research activity is more problem-based and involves appropriate strategies to overcome the existing problem (Creswell, 2014). This study is based on an experimental research method, which is "I-we" form of Action Research (AR). In general, there are three forms of AR (McNiff & Whitehead, 2006). Among these three forms, I utilized critical action research to engage "subjects: researcher" and "objects: participants" with interest in common problems. This one-cycle AR was carried out in the Central Department of Education (CDED) in the Faculty of Education at Tribhuvan University. This AR is based on an intact group pretest-posttest design. One possible way to minimize problems related to having no control group is to apply pre- and posttest same group design and measure the same dependent variable in the same group before intervention (pretest), provide a treatment or intervention, and then measure the variable again in a posttest. While using this type of research design, it is possible to measure scores before and again following treatment, and then compare the difference between the pretest and posttest scores.

The study participants were students of the master's program at CDED in a course called Differential Geometry during the 2017 semester. In this semester, 167 students were enrolled. However, 126 students (111 Boys, 15 Girls) participated in both pretest and posttest surveys. Therefore, 126 students were considered participants in this study.

As an AR-based research design is used, this study had utilized both quantitative and qualitative data. In this context, I have used three data generation tools for this study: These tools were 1) Survey for *Learning Preferences and Styles*, 2) Digital Pedagogy log report from Moodle database, and 3) interview guideline. The survey questionnaire used in this study is based on the *Index of Learning Preferences and Styles (LPS)* survey which was adopted from Felder and Silverman's (1988) learning style index. In LPS, there were 21 items in bi-categorical form. Among 21 items, there were 7 items in each three learning style dimensions: visual-verbal, visual-interactive, and interactive-verbal. In learning resource preference, there was an item with a Likert format. Also, two open-ended items with 1 item [open] for opportunities and 1 item [open] for challenges were used. For the reliability and validity of the survey, a pilot study was carried out on 125 students at CDED in a course called Differential Geometry during the 2016 semester. Cronbach's alpha coefficient for the pilot study reliability survey was 0.86. It states that internal consistency reliability for attitude measures should be 0.5 or higher. Therefore, the reliability of *LSP* was accepted.

In addition, interview guideline was used in this study. This interview guideline was used to investigate how DP contributed to a resourceful learning environment to address individual learning preferences and styles in higher mathematics. The interview items were designed to include follow-up and prompting questions to encourage participants to speak about what they do, rather than they simply say. After the DP intervention, interviews were conducted with 12 students; 2 students from each case level; a) Boys, Girls; b) Low access, Moderate access, and High Access. Each interview lasted for about 30 minutes. Each interview was audio recorded in a digital audio recording device. The audio record was transcribed by the researcher himself and coded using Atlas.ti 8 qualitative data analysis software. The data was analyzed in a constructionist way to uncover the meaning-making processes. For this analytical process, a constant comparison method with an analytic induction were followed. In the beginning, the transcription was carefully noted as meaningful quotations and marked them as codes. Both inductive and deductive coding approach was used. The codes were classified using Families of Codes. The researcher's personal reflections were updated in memos using Atlas.ti. Then meaningful and related codes from the data and reflections were analyzed using super-codes.

The quantitative data obtained through LPS was analyzed using inferential statistics using the Statistical Packae for Social Sciences (SPSS Version 26) and that of interview by thematic analysis using deductive coding Atlas.ti.

Results/Findings

The participants in this study were M. Ed third semester in a course called Differential Geometry during the 2017 semester at the Central Department of Education, Tribhuvan University. The study participants were 126 in the class. Among 126 students, 111 were boys (88%), and the remaining 15 were girls (12%) DP database was retrieved from the Moodle log report. Retrieved databases were on grades, resource access, day access, course hits, and time stat. These five levels of data were merged, and DP access scores were formulated.

Table 1: Students cohort in DP Access

	DP Access Level (N)			DP Access Level (%)			
Gender	Low	Moderate	High	Low	Moderate	High	Chi Square
Boys	39	38	34	92	90	81	3.17
Girls	3	4	8	8	10	19	

(N=126 of 167)

Based on the DP access database score in Moodle, 126 students were divided into three cohorts. These three cohorts were coded as High-level DP access, Moderate-level DP access, and Low-level DP access.

In this study, a question asked in the survey was, "For the purpose of reading/learning, what learning resources do you prefer most?" There were six options to respond. The options were: textbook, image, picture, teacher handout, audio/visual materials, internet resources, and interactive resources. While reporting the responses, textbook and teacher handouts were coded as Text level learning resources; image, pictures, and audio/visual materials were coded as Media level learning resources; and internet resources and interactive resources were coded as

Interactive level of learning resources. Based on these three levels of learning resource preferences: Text, Media, and Interactive, the students learning resource preferences were analyzed based on DP access level.

Table 2: Students' Learning Resource Preferences in Pretest

Test	Learning Resource Preferences						Chi-Square
	Graphics	Media	Text (N)	Graphics	Media	Text (%)	
Low	6	13	23	14	31	55	3.38
Moderate	7	10	25	17	24	59	
High	7	6	29	17	14	69	

(N=126 of 167)

A chi-square test of independence was performed to analyze whether the resource preferences varied across DP access levels. The result Table 2 showed that the test was NOT significant, $\chi 2$ (2, N = 126) = 3.38, $p>0.05$. Therefore, it is concluded that DP intervention and students' preferred learning resource type are not related.

Table 3: Students' Learning Resource Preferences in Posttest

Test	Learning Resource Preferences						Chi-square
	Graphics	Media	Text (N)	Graphics	Media	Text (%)	
Low	18	14	10	43	33	24	22.73
Moderate	18	13	11	43	31	26	
High	1	20	21	2	48	50	

(N=126 of 167)

After the DP intervention, a chi-square test of independence was performed to analyze whether the resource preferences varied across DP access levels. The result Table 3 showed that the test was significant, $\chi 2$ (2, N = 126) = 22.73, $p<0.05$. Therefore, it is concluded that DP intervention and students' preferred learning resource type are related.

From the analysis of pretest and posttest results, it was found that DP intervention ensured that students' preferred learning resources were found in the DP.

In this study, students' preferred learning styles were analyzed. The results of the analysis have been presented in Table 4 below.

Table 4: Students' Learning Style in Pretest

Test	Learning Style Verbal	Visual	Interactive (N)	Verbal	Visual	Interactive (%)	Chi
Low	19	20	3	45	48	7	3.53
Moderate	17	22	3	41	52	7	
High	23	14	5	55	33	12	

(N=126 of 167)

A chi-square test of independence was performed to examine whether there is a relationship between DP access level and students' learning styles. Table 4 showed that the test was NOT significant, $\chi 2(4, N = 126) = 3.53, p>0.05$. Therefore, it is concluded that there is no relationship between DP access level and students' learning style at the pretest.

Table 5: Students' Learning Style in Posttest

Test	Learning Style Verbal	Visual	Interactive (N)	Verbal	Visual	Interactive (%)	Chi
Low	4	29	9	10	69	21	4.31
Moderate	1	35	9	3	83	14	
High	1	32	9	3	76	21	

(N=126 of 167)

After DP intervention, a chi-square test of independence was performed to examine whether there is a relationship between DP access level and students' learning style. Table 5 showed that the test was not significant, $\chi 2$ (4, N = 126) = 4.31, p>0.05. Therefore, it is concluded that there is NO relationship between DP access level and students' learning style in the posttest.

From the analysis of pretest and posttest results, it was found that DP intervention did NOT ensure that students' preferred learning style within DP. It explains that students are learning through all learning styles.

In this study, in addition to quantitative results on what DP addressed learning preferences and style in higher mathematics, qualitative data were gathered on how DP contributed to a resourceful learning environment to address individual learning preferences and styles in higher mathematics. For this purpose, interviews were conducted with 12 students (2 students from each case, DP access, and gender). The interview responses were analyzed using ATLAS.ti 8: qualitative data analysis software.

To identify how DP is contributing to individual learning preferences and style, the question 'How is DP helping you in your learning?' was asked of the students during the posttest survey. The responses to the survey and interview were coded in ATLAS.ti using inductive and deductive coding on three themes: text, media and Interactive; and inductive coding for other codes. There were 22 codes altogether. These 22 codes were associated with 148 quotations. These codes were recorded as learning preferences and styles. These 22 codes were grouped into categories. The categories were: 21^{st}-century learning skills [3 codes, 13 quotations], any time anywhere learning opportunity [3 codes, 36 quotations], and e-resources repository [16 codes, 99 quotations]. These three themes have been discussed separately.

Compatibility to 21st-century Learning Skills

Some responses in a theme, "21^{st}-century skills," were tabulated below.

Table 6: Students' Responses on 21^{st}-Century Skills

Responses	Tags
[1] "Using Moodle, I came to know that the internet is a place where I can learn. I found a GeoGebra file in internet, and then I created dynamic applet of cylinder myself, which I had never done before."	*creative*
[2] "...these days, I rarely go to the library where I have to follow catalogue, and still, I hardly get the book. Nowadays, I prefer internet search. Now I prefer to use internet things for learning."	*critical thinking*
[3] "Using my Moodle, I see various posts in discussions in the forum. I asked a question, and I got the concept of "order of contact."	*communication collaboration*

From the data presented in Table 6 [1] above, it is found that DP intervention has promoted 21^{st}-century learning skills: Creativity/ Innovation. DP intervention has enabled students' creativity to browse internet resources and select appropriate learning content themselves. From the data given above, it is found that DP interventions have become a learning space where the student not only learn mathematical content but also, they also learn to share their ideas among the learning community. From the data in Table 6 [3], it is found that DP intervention has promoted students' capability of social networking to realize how to learn. The data showed that students had used communication tools like discussion forums using DP to communicate with friends and teachers. Students realized that they could share their ideas whenever needed. They were equally using other communication tools like email, SMS, Facebook chats, and Moodle comments to address their queries and problems. In this essence, DP intervention promotes students' communication and collaboration skills.

Anytime Anywhere Learning Environment

In this study, students' responses were acoded for "anytime anywhere learning". Anywhere anytime learning is a web-based learning space. This web-based learning space has created opportunities for student learning beyond F2F and campus boundaries.

Table 7: Students' Responses on Anytime Anywhere Learning

Responses	Tags
[1] Moodle has provided learning resources 24 hours- a time, it made mathematics easier and international level study." *[2] "I have Moodle apps in my mobile, I am frequently login into Moodle through this Mobile and see necessary things that I am confused in."* *[3] "Moodle has given learning environment, now we can learn at home also."*	*Anytime Anywhere*
[4] "I have repeatedly attempted quiz through Moodle, and read resources and learn." *[5] " I downloaded video watched it 3 times, until I understand the theorem."*	*pace*

Table 7, [2] shows that DP intervention is found to have the potential for students' anywhere, anytime learning opportunities. DP intervention has enhanced students' learning opportunities beyond real-time and real location. Also, DO intervention has addressed students learning opportunities with internet-based learning space. It has addressed students' learning race and pace. These showed that DP intervention has provided individualized feedback and support on students learning. Therefore, students found that DP intervention has provided them with self-paced learning opportunities anytime, anywhere.

E-resource Resource Repository

In this study, students' responses were also coded for "E-Resource Repository." Resource Repository is a location where students can access required learning materials whenever needed. In this essence, DP intervention is found to be a resourceful learning space.

Table 8: Students' Responses on E-Resource Repository

Responses	Tags
[1] I had a problem understanding why the uniqueness theorem is fundamental; I learned it from a file in Moodle.	*explained text*
[2] "Audio lecturers in DP helped me to learn fundamental difference between curvature and torsion. I had understood that curvature and torsion both measures curvedness, but audio made me clear that there is difference in measures." *[3] "I found videos more helpful. Watching video, I felt like that I am learning in real class."*	*media*
[4] "I understood osculating plane as 3D plane. But a video elaborated in Moodle help me to better understand. Now I correctly understand that it can be 2D plane, in 3D, it is moving plane along a point on the curve."	*interactive*
[5] "I like Moodle because I am getting all needed resources in Moodle. When I face any problem, first I go to Moodle, search things, and write to my teacher/friends if necessary."	*repository*

Table 8 shows that students are using text, media, and interactive resources sufficiently through DP. From the data analysis, it is found that DP intervention has contributed to students learning from various resources like explained text, text, media, videos, audio, and interactive template. Therefore, students found that DP provided them with necessary learning resources as an e-resource repository. In this way, DP intervention contributed to individual learning preferences and styles by enabling 21st-century learning skills, providing learning opportunities for anytime, anywhere learning, and by allocating e-resources repository whenever needed for students' learning.

Discussions

The result shows that Digital pedagogy can facilitate effective learning experiences that cater to the diverse learning preferences of students in mathematics education. This research indicates that digital pedagogy has seven parameters: 1) Learning Contents/Curriculum Mapping, 2) Setting Learning Outcomes, 3) Selecting and organizing Learning Resources, 4) Designing Learning Activities/Assignments, 5) Ensuring Learning Communication/

Interaction/ Discussion, 6) Learning Feedback/ Support, and 7) Learning Assessment/Evaluation. These parameters can provide adaptive learning experiences that can be adjusted to the learning pace and styles of each student, enabling learners to learn at their own pace and achieve their full potential. In this research, it was found that digital pedagogy ensures learning preferences and styles through personalized learning. Personalized learning refers to an approach where students' individual needs, preferences, and learning styles are considered, and instruction is tailored accordingly (Mandinach & Cline, 2013). Within this definition, in this study, 7-parameter formulated DP helped learners to receive personalized learning experiences. It is said in the literature that adaptive learning software uses algorithms to analyze students' performance and adjust instruction accordingly (Brusilovsky & Peylo, 2003). Another way in which digital pedagogy can accommodate learning preferences and styles by using various resources. Various resources refer to learning materials that combine different modes of representations, such as texts, images, and videos. In the literature, it is mentioned that such approach caters to students' different learning styles, as “some students may learn better through visual aids, while others may prefer text-based materials” (Mayer, 2009,). Therefore, it is concluded that these 7parameters formulated DP that can ensure that students' learning preferences and styles are accommodated by providing opportunities for self-paced, engaged and active learning. Active learning refers to an approach where students are engaged in hands-on, collaborative, and problem-based activities (Freeman et al., 2014). Also, Digital tools such as educational games and simulations has provided opportunities for active learning, allowing students to engage with mathematical concepts in a fun and interactive way. In conclusion, it is found that various resources enabled DP to ensure SPL by providing personalized learning experiences, multimodal resources, and opportunities for self-paced active learning.

Implications

This study, "Digital Pedagogy for Self-paced Learning in Mathematics Education," can provide a valuable guidance for educators, policymakers, and researchers in the field of mathematics education. For example, (a) Educators should consider integrating digital resources and interactive materials into their curriculum design to promote self-directed learning. (b) Given the changing landscape of education, teacher training programs should emphasize digital literacy and pedagogical skills related to online and self-paced learning. (c) Educational institutes should invest in platforms and technologies that facilitate personalized learning experiences in mathematics. (d) Teachers can use gamification apps to maintain students' motivation and engagement throughout their learning journey.

Conclusion

In conclusion, digital pedagogy is essential for ensuring effective self-paced learning in mathematics education to access resources and personalized learning experiences that cater to their learning preferences and styles through 1) 21st-century learning skills: Digital pedagogy promotes the development of 21st-century learning skills such as critical thinking, problem-solving, collaboration, and communication 2) Any time anywhere learning opportunity: Digital pedagogy enables students to learn at their own pace, anytime and anywhere, using a range of devices. This flexibility allows students to balance their learning with other commitments and empowers them to take ownership of their learning process, and 3) An e-resource repository: Digital pedagogy provides a repository of e-resources that students can use to supplement their learning. These resources include videos, simulations, interactive activities, and online textbooks that cater to different learning styles and preferences.

Limitations

Here are some potential limitations for this study, "Digital Pedagogy for Self-paced Learning in Mathematics Education". Generalizability: The study has been conducted on Master level students with specific educational setting of Digital learning Environment, which limits the generalizability of the findings to broader and general educational surroundings. The study has been conducted over one semester period. Therefore, the short intervention may have a limtied generalization of the findings to the other contexts. The study is based on researcher as a teacher model, so teacher's expertise, instructional methods, and support for students might have significantly impacted the results of this research.

References

AlZoubi, O., & Aburezeq, I. (2017). Integrating technology into mathematics education in Jordan: A mixed-method study of effectiveness and self-paced learning. *International Journal of Educational Technology in Higher Education, 14*(1), 6.

Bishop, A. J., Clements, K., Keitel, C., Kilpatrick, J., & Laborde, C. (1997). *International Handbook of Mathematics Education Part 1*. Retrieved from http://dx.doi.org/10.1007/978-94-009-1465-0

Brusilovsky, P., & Peylo, C. (2003). Adaptive and intelligent technologies for Web-based education. *International Journal of Artificial Intelligence in Education, 13*(2-4), 159-172.

Clements, M. A. (Ed.). (2013). *Third international handbook of mathematics education*. New York; London: Springer.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches (4th ed).* Thousand Oaks: SAGE Publications.

Dinkmeyer, D. (1969). *Personalization— Individualization for Learning*. Wyoming: Wyoming State Dept. of Education, October 10-11, 1968. Presented at the Personalization--Individualization for Learning, Cheyenne, Wyoming.

English, L. D. (2002). *Handbook of international research in mathematics education*. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=68980

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410-8415.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Grouws, D. A. (Ed.). (1992). *Handbook of research on mathematics teaching and learning.* New York: London: Macmillan Library Reference USA ; Simon & Schuster and Prentice Hall International.

Jared, K. (2015). *Handbook of research on educational technology integration and active learning*. IGI Global.

Lester, F. K. (2007). *Second handbook of research on mathematics teaching and learning*. IAP.

Mandinach, E. B., & Cline, H. F. (2013). Classroom assessment in the context of learning theory and research. *Educational Measurement: Issues and Practice, 32*(4), 14-22.

Mayer, R. E. (2009). *Multimedia learning*. Cambridge University Press.

McNiff, J., & Whitehead, J. (2006). *All you need to know about action research*. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=326402