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Technological Tools and Methods Used in Formative Assessment Activities

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Technological Tools and Methods Used in Formative Assessment Activities

by
Lisa Goldsmith

An Applied Dissertation Submitted to the
Abraham S. Fischler College of Education
and School of Criminal Justice in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Education

Nova Southeastern University
2023

Approval Page

This applied dissertation was submitted by Lisa Goldsmith under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and School of Criminal Justice and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

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Statement of Original Work

I declare the following:

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June 6, 2023
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Abstract

Technological Tools and Methods Used in Formative Assessment Activities: Lisa Goldsmith, 2023: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and School of Criminal Justice. Keywords: educational assessment, technology uses in education, educational technology, instructional effectiveness

This applied dissertation examined the use of technological tools in formative assessment activities. These phenomena have left teachers searching for timely methods to perform formative assessment or assessment for learning activities. The problem addressed by this study was that standardized testing, large class size, and increasing distance learning at all educational levels, achieving formative assessment tasks necessary for successful learning can be a challenge. The sample from which data was gathered was 189 studies and academic articles. The target of the assessment process became apparent in many of the sections studied, which led to information about the impact of the targeted formative assessment activity on the ongoing learning process. The data were examined to discover if the assessment target information led to new teaching and learning activities, changes in ongoing learning activities, or if the integration of the assessment target was a planned part of the lesson to begin with. These findings illustrated a need for continuing education for instructors, at all levels of education, in the use of the various tools and methods of achieving formative assessment tasks using technology.

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Chapter 1: Introduction

Statement of the Problem

To facilitate current and lifelong learning, the teacher and the student must evaluate not only whether the student is learning, but also how the student is learning. This is accomplished through a process called formative assessment. Formative assessment occurs when instructors or learners receive evaluative feedback during learning experiences that assists in adjusting or maximizing the learning experience. This feedback can be about how the student is learning, whether the student is learning, or specifically about a factor within a concept that the student is failing to grasp (Brookhart & Nitko, 2018). The problem is that, in the recent era of high-stakes standardized testing and large class sizes, accomplishing the formative assessment tasks needed for effective learning can be a challenge. In addition to the pressures of teaching to standardized tests, recently education was impacted by the pandemic of COVID 19, forcing schools to exist in a fully online format (Khanal, 2021). Technology exists that can help instructors perform formative assessment tasks in a timely and efficient manner. However, instructors often fail to utilize this technology due to a lack of understanding of the technology or a lack of knowledge of the existing evidence that it will help (Brookhart & Nitko, 2018; Fox-Turnbull, 2019).

Phenomenon of Interest: Formative Assessment

Formative assessment provides both instructor and student with information about what and how a student is learning. This information is used to adjust the learning process to create greater success in both immediate and long-term learning objectives. Adjustments are made to material, practices, and individual learning processes in relation to formative assessment data. These data may come in the form of feedback to students or

diagnostic information for teachers (Simonson et al., 2019). There are several methods of achieving formative assessment goals. Formative assessment can be performed through tests, tasks, projects, and classroom discussions. It can be embedded in activities that utilize technology as a tool.

Digital assessment records, digital feedback on authentic assessment assignments, and hardware such as mobile devices all facilitate timely and effective formative assessment activity (Simonson et al., 2019). With the help of these tools, formative assessment can be used to change instruction, adjust learning habits, and even create a sense of ownership of learning within the individual student (Brookhart & Nitko, 2018; Simonson et al., 2019). Formative assessment can be used as assessment for learning, but it can also be used as assessment as a part of the learning process. When teachers and students share feedback and goals as part of the learning process, student critical reflection occurs, automatically adjusting the learning process toward greater success (Fox-Turnbull, 2019; Simonson et al., 2019).

Though there are teachers who make optimum use of technology-based formative assessment tools, many teachers need to know what technology-mediated resources are available to assist them in finding out what students know and can do, as well as how they learn. Some teachers find certain difficulty in utilizing these assessment tools, and, for some, the need to use technology to accomplish these assessments is the barrier that needs to be examined and overcome (Fox-Turnbull, 2019). In recent years, with the growing utilization of distance learning, this technology becomes even more important (Lowenthal et al., 2017; Robertson et al., 2019). As part of solution to these issues, an examination of formative assessment practices that synthesizes numerous studies, many of which have small or localized samples, will give educational professionals a view of

what data show about formative assessment practices and results.

Background and Justification: Barriers to Formative Assessment

Several barriers stand in the way of teachers accomplishing formative assessment goals in the distance learning classroom. These include communication difficulties, time spent on summative standardized testing activities, and practices surrounding those activities. To understand how certain distance learning classroom conditions and activities behave as barriers to formative assessment, it is important to describe those conditions and activities. Summative, large-scale, standardized testing and the time devoted to it is one of the barriers to formative assessment activity in the classroom. Summative assessment is used to determine whether students have reached certain learning objectives after the learning activities are completed. Standardized testing is a form of assessment that follows a set of standards for the administration, scoring rules, and materials involved in the assessment. Standardized testing commonly provides summative data about student learning, but those data often take a full school year to filter down to classroom teachers (Brookhart & Nitko, 2018).

Large-scale testing is performed with the standardized tests mentioned above. Data from large-scale testing typically is used for comparison purposes. Schools are compared to schools, students to students, or either of the above to stated norms. The data and comparisons are used for purposes not related to the day-to-day teaching practices in schools, but it could be used for higher level curricular planning (Brookhart & Nitko, 2018). When a district attaches a high level of importance to the results of standardized testing, and combines that with large class sizes, the result is inadequate time being devoted to other learning activities in the classroom. This includes formative assessment activities. High-stakes, standardized testing creates a situation in which students and

teachers are forced to focus a large portion of classroom time on standardized tests of often minimal skills rather than more helpful assessments of higher level skills (Roblyer & Hughes, 2018).

At the height of the COVID 19 pandemic, 1.6 billion students across the world experienced school building closures. That number represents 94% of the world's students. Schools in some affected areas ceased to provide education in any form during these closures (UNESCO, 2020). In other parts of the world, communities tasked their schools with finding alternative ways to educate students. Schools found themselves trying to reconfigure the very idea of education in a no contact situation. Most of these schools relied on technology to continue education, utilizing online educational tools (Khanal, 2021).

Deficiencies in the Evidence

The online learning emergency happened with little time for preparation of students or teachers. One of the biggest obstacles to the success of this alternative was students being unprepared for no contact learning. Effective formative assessment accomplished through the use of technological tools is required to successfully educate in an online environment(Chandran et al., 2021). The current use of formative assessment as a vital part of educational planning needs to be explored (Richards, 2020). Many and varied studies have been completed that document the use and results of the use of technology for formative assessment purposes. A comprehensive study compiling, comparing, and analyzing the information available about the achievement of authentic, formative assessment goals may be instrumental in moving the educational community forward during the next era in education. The information, as it now exists, is found in scattered studies that examined often small and localized populations. Brought together

and synthesized, this information can paint a picture of formative assessment practices that can be used by the educational professional as a both a justification and a template for using formative assessment practices in the classroom.

Definition of Terms

For the purpose of this applied dissertation, the following terms are defined.

Authentic Assessment

This term refers to the assessment of student performance of meaningful tasks or student solutions to unstructured, real world problems that demonstrate student knowledge and skills (Brookhart & Nitko, 2018).

Coaching

This term refers to the act of assisting students in attaining learning goals through positive and corrective feedback (Ali et al., 2018).

Comparative Appraisal

This term refers to an appraisal that can be used to compare similar and significant characteristics of data in different studies, with the researcher synthesizing the information to illuminate trends within the phenomena (Mayring, 2019).

Constant Targeted Comparison

In a constant targeted comparison, the researcher finds similarity and differences in data of various studies that is related to a target phenomenon. This information is then synthesized into a set of findings (Moeller, 2021).

Constructive Feedback

This term refers to feedback that is useable by the student because it relates directly to the assessment target and is clearly stated in a way that the student understands (Bates & Donaghue, 2021).

Constructivist Theory of Education

This term refers to a theory of education indicating that children construct knowledge through experiences (Roblyer & Hughes, 2018). The idea is that knowledge is put together from coordinated practice. An educator would be responsible for arranging for the experiences that would demonstrate the learning target (Brookhart & Nitko, 2018).

Corrective Feedback

In response to an incorrect or inaccurate answer, information provided by the instructor that provides or leads the student to the correct answer is corrective feedback (Udeshinee et al., 2019).

Descriptive Feedback.

This term refers to feedback that explains correction needed by pointing out the characteristics of the student's evidence of learning that are incorrect or off the mark (Simonson et al., 2019).

Diagnostic Feedback

This term refers to feedback that uncovers the areas of learning in which students are not achieving the learning goals. The purpose of this feedback is to identify needs to be used to instigate corrective action (Brookhart & Nitko, 2018).

Ethnography

Ethnographies are used to describe groups that share certain social and or cultural characteristics. It is helpful in describing the behavior and experiences of individuals in the context of cultural or social situations (Creswell & Creswell, 2017).

Formative Assessment

This term refers to information that tells the instructor how a student learns, where

the student might be missing something, and allows the instructor and student to apply

adjustments to the learning experience to optimize it. Standardized multiple-choice

examinations do not usually confer any formative assessment information (Brookhart &

Nitko, 2018).

Goal

This term refers to an expressed declaration of what a student will know or be

able to do as a result of instructional intervention (Brookhart & Nitko, 2018).

Internalization

This term refers to transforming information from outside of oneself into

knowledge held within a paradigm or understanding of a topic or concept (Ali et al.,

2018).

Metalinguistic Feedback

This term refers to feedback that is used to guide the student to the correct

linguistic form without explicit correction (Canals et al., 2020).

Phenomenology

A phenomenology describes experience. It is a method used by researchers to

discover and describe how an individual experiences a phenomenon (Creswell &

Creswell, 2017).

Qualitative Metasynthesis

This term refers to a method used to interpret and synthesize data from qualitative

studies including phenomenologies, ethnographies, and grounded theory studies. A

qualitative meta-synthesis integrates the information gained through the descriptions and

explanations of phenomena that are created through these studies to create the larger

picture of the state of the data (Finfgeld-Connett, 2018).

Scaffolding

This term refers to an instructional strategy that expands on the constructivist theory in that students construct new knowledge by adding on to previous knowledge. Scaffolding is the method used to coordinate the practice noted in the definition of constructivism (Roblyer & Hughes, 2018).

Skill

Competence in completing tasks related to topic or concept is referred to as a skill (Brookhart & Nitko, 2018).

Purpose of the Study

The purpose of this qualitative study was to explore formative assessment practices and the technological tools available to assist in achieving formative assessment goals. Both would assist educators in better utilizing formative assessment tools to plan appropriate and useful educational experiences for students. As current practices are examined and the data regarding them are synthesized, a practical picture of various methods and results of formative assessment will emerge. Numerous studies of various aspects of this topic have been completed and reported on, usually using convenience samples. Each of these studies alone presents a significant result about the related convenience sample. As a scholarly tool, these studies, examined side by side with similar studies, present a picture of the state of formative assessment and the use of technology to accomplish this important aspect of education.

Conclusion

This study examined the problem created by time constraints and overwhelming demands in the classroom, limiting the ability of instructors to achieve formative assessment goals. The exclusive use of online education during the COVID-19 pandemic

created further need for performing formative assessment activities utilizing

technological tools. Specifically, the use of technology to assist in achieving those goals

was examined. Many studies have explored the various aspects of this phenomenon;

however, these studies generally focused on a convenience sample in the locality in

which the researcher was employed. This study explored the existing data to create a

picture of the existing technologies, how they are being used, and the results being

attained through their use. Instructors should be able use this analysis of the existing data

as a tool in choosing and using technology to accomplish formative assessment goals.

Chapter 2: Literature Review

Introduction

In this study, technology-mediated formative assessment was examined through the lens of scaffolding theory of constructing knowledge by comparing problem-based learning (PBL) and information and communication technology (ICT) activities occurring in classrooms. This summary of the available literature examined the technology tools used by both teachers and students for formative assessment, teacher adoption of technology use for formative assessment practices, and some of the methods of formative assessment that have been recently studied. The stated purpose of this study was to examine the impact of technology-mediated formative assessment on various aspects of PBL and other experiential learning models based in the constructivist theory.

Theoretical Framework

The narrative of a study is expressed through the structure of a theoretical lens. Several pedagogical and psychological theories are available through which the information contained in this study could be examined (Creswell & Creswell, 2017). Modern pedagogical theories are often a combination of the behaviorist and cognitive schools of thought (Roblyer & Hughes, 2018). Methods that rely heavily on theories based in the behaviorist ideology tend to look at education as a process through which instructors try to change the performance of students through the use of consequences and the reactions to stimuli. These methods tend to focus on performance tasks rather than cognitive structures. Methods that follow behaviorist ideas are valuable in teaching fact memorization, concept definition, and rote task attainment (Ertmer & Newby, 2013; Roblyer & Hughes, 2018). In the realm of pedagogical theories, these often fall in the objectivist category of theories, which rely on methods developed through observed

behavior and quantitative data to accomplish quantifiable educational goals. Objectivist-based methods tend to be teacher centered and rely on reinforcement and external stimuli to achieve learning goal (Roblyer & Hughes, 2018).

Cognitive theories focus on the process of attaining knowledge by examining cognitive schema. Methods that employ cognitive theories do not focus on performance, but on processes that occur in the brain. Cognitive theories examine how information is attained, processed, stored, and accessed when needed. Methods rooted in cognitive theory tend to be used for learning concepts, complex ideas, and problem solving (Roblyer & Hughes, 2018). Constructivist learning theories are based in cognitive theory, in which focus is placed on cognitive processes, and as such, tend to be centered around the student's cognitive processes (Roblyer & Hughes, 2018).

This content analysis study examined educational methodologies rooted in the constructivist theory of education and scaffolding theory (Roblyer & Hughes, 2018). Constructivist theory describes learning as a construction of knowledge through experience. In this theory, all learning is related to previously held knowledge such as cognitive schema, personal background, learner experiences, and learner aptitudes (Roblyer & Hughes, 2018). Methods that employ the constructivist theory of education tend to focus on the behavior of the student, rather than that of the teacher. Special attention is paid to student activities and motivation (Becerra & Castorina, 2018). The job of the instructor in constructivist methods is that of guiding students in various learning activities, allowing the student to construct solutions and learning behavior. Instructors help students by creating parameters that ensure consistency within the learning process (Becerra & Castorina, 2018; Juvova et al., 2015). Productive communication within these learning processes can go in several directions, including teacher to student, student to

teacher, and student to student (Pratiwi & Jailani, 2018).

Constructivist theory has been developed from two different perspectives: cognitive constructivism and social constructivism. Cognitive constructivism, based on theories developed by Piaget, holds that the students construct knowledge cognitively, adding new information to previously constructed schema, and, in this way, they make sense of external information. Social constructivism, as developed by Vygotsky, states that learners construct new knowledge through the interpretation of environmental stimuli using previous knowledge. In social constructivism, it is the interaction that causes the learning (O'Connor, 2022).

Constructivist theory is based on certain principles. In constructivist theory, particular attention is paid to student behavior, motivation, and learning style. Instructors guide students to develop an internal learning system based on constructing knowledge through problem solving and relating interdisciplinary material. The role of the instructor is important in maintaining continuity and consistency, while activities are adjusted to meet student needs. It is important in constructivist learning environments, for communication to proceed in all directions: from learner to instructor, from instructor to learner, and from learner to learner (Pratiwi & Jailani, 2018). To summarize constructivist learning theory, learners are required to seek knowledge actively to solve problems. They do this by finding and organizing information about the problem. They then interpret and analyze that information to draw conclusions that will create knowledge pertaining to the problem, and the broader schema relating to the problem (Pratiwi & Jailani, 2018).

Theories have been developed within constructivist theory. Scaffolding theory relies on building on prior information and schemas to create internalized, long term

learning. Applying scaffolding theory, an instructor assesses student skills, knowledge, and aptitudes. Tasks are then assigned that are just beyond student abilities, and instructors guide activities that allow students to gain that next level of knowledge and skill (Hendriana et al., 2018). The application of scaffolding theory to the PBL method is one characteristic that keeps it from becoming minimal instruction. The facilitator or instructor in PBL is responsible for assessing student knowledge and skills, identifying gaps, and guiding the learning experience (Hendriana et al., 2018). This means that the instructor structures the learning experience and defines the problem to be solved in such a way so as to assist in the scaffolding of knowledge so that students can build learning upon learning, while focusing attention to the proper sources, with the student, eventually achieving self-learning skills. The instructor is the expert who serves as one of the sources students can use to address issues (Hendriana et al., 2018; Pratiwi & Jailani, 2018).

Experiential learning methods have been developed utilizing the constructivist theory. It is important that students use a systematic method to attain knowledge and understanding of the problem being explored. That systematic approach is also used to discover a broader context of the problem (Pratiwi & Jailani, 2018). The PBL, ICT, and other experiential learning models involve the construction of knowledge through the student's interaction with a real-world problem. Content is not communicated through a lecture based lesson, but through inquiry, using a constructivist framework (Pratiwi & Jailani, 2018). Students are asked to examine an assigned problem, identifying the gaps in knowledge and skill and addressing those gaps through self-directed learning (Roblyer & Hughes, 2018). The students generate learning tasks by looking for the solutions to everyday problems assigned. Students then evaluate those solutions through self-

assessment, peer feedback, and instructor guidance. This causes them to apply critical reflection skills to the information, and to adjust the learning process accordingly (Hamilton, 2018; Roblyer & Hughes, 2018). When using technology to achieve these goals, students engage in interactive communication activities that help to the develop knowledge based on their analysis and critical reflection on the information received in the problem solving activity (Brookhart & Nitko, 2018). Built into this process are formative assessment activities that will, in turn, motivate the learner to question instructors and to seek out sources to bridge gaps in knowledge and skill (Brookhart & Nitko, 2018).

The type of situated learning experience described above anchors the knowledge and skills through the solving of authentic problems that the student might encounter in real life. This creates both procedural and phenomenological knowledge, which is often referred to authentic instruction, and is evaluated through authentic assessments (Pratiwi & Jailani, 2018). Meaningful tasks that address an unstructured real world problem are examined in an authentic assessment evaluation of student gains in knowledge and skill (Brookhart & Nitko, 2018). This practice allows for the identification of the knowledge or skill base attained by the student, as well as the gaps in that knowledge. The authentic or situated learning activity then builds on the existing knowledge to fill the gaps through appropriate methods as discovered through critical reflection on instructor and peer feedback (Brookhart & Nitko, 2018).

The ICT model describes the process of using technology as a tool for research, communications, and critical reflection. Learners use technology to find information. They also use technology to share their understanding of that information, to receive feedback from instructors and peers, and to receive direct instruction about that

information (Roblyer & Hughes, 2018). This leads to an important critical reflection process in which students reflect upon the work performed, ideas presented by others, and how their own ideas are shaped in this process (Hamilton, 2018). Building on constructivist theory, students use information gained through ICT methods to build on previous knowledge and schema to create new or more complete knowledge and schema (Roblyer & Hughes, 2018). ICT is a tool that can be valuable in the hands of an instructor who applies knowledge of pedagogy to properly use that tool to accomplish the above activities (Roblyer & Hughes, 2018).

Critics of the constructivist theory have stated that it is merely a collection of ideas rather than a cohesive theory. Constructivism differs from other cognitive theories in that it incorporates information from environmental factors into existing schema to create knew knowledge (O'Connor, 2022). Yet, other critics believe that constructivism can be too self-contained in that it does not encourage students to examine the relationships between cognitive schema construction and social interaction. Reality, or the external environment, plays a role in knowledge construction. Self-contained schema cannot build knowledge absent an examination of external factors (Becerra & Castorina, 2018). However, these critiques may be addressed in the discussion of social constructivism above, or in a combined constructivist theory that encompasses both social and cognitive constructivism (Roblyer & Hughes, 2018). A final critique of constructivism is that teaching methods based in this theory are often in conflict with standardized methods, curriculum, and assessments. Activities basted in constructivist theory tend to use project-based assessment with rubric scoring, and the individual nature of constructivist learning are often in conflict with standardized curriculum (O'Connor, 2022; Roblyer & Hughes, 2018).

Evidence in several studies has shown that PBL and inquiry learning provides high-level learning and improved performance in attaining educational goals (Pratiwi & Jailani, 2018). Further research results have shown that PBL prepares students for future learning (Pratiwi & Jailani, 2018). Standardized summative assessments will not show the gains that achievement tests do. The use of assessments that measure process goals, such as problem-solving skills, reasoning skills, and personal processes are the type of formative assessment during the process of learning leads to the adjustment of learning activities and is what develops the internalized skills needed to be lifelong learners (Brookhart & Nitko, 2018).

Constructivism has been studied extensively. Social and cognitive constructivism are two branches of the theory that attempt to explain how knowledge is constructed during learning (Roblyer & Hughes, 2018). A theory within the constructivist theory, scaffolding, examines how learning is built upon previous knowledge through both cognitive and social activity (Roblyer & Hughes, 2018). Several methodologies, including PBL, inquiry learning, and situated learning follow the various principles of constructivist theory (Pratiwi & Jailani, 2018). Technology is often used as the medium for formative assessment in PBL activities. Critiques of constructivist theory have centered on cognitive activity being insufficient in itself to create new knowledge (O'Connor, 2022). An examination of instructor guidance, peer communication, and critical reflection provides a clearer picture of how learning methods created around constructivist theory can be well rounded and effective (Simonson et al., 2019). A review of current literature on the topic of technology use in formative assessment is valuable in describing how instructors and learners are using technology for the formative assessment tasks in PBL and the historical context into which these activities have come

to be developed.

Historical Context: Trend in Education

Karaman and Celik (2008) stated that teaching is moving toward a constructivist model. Formative assessment examines where knowledge construction is needed for individual students and provides information that can be used to create the learning and teaching changes that will result in that knowledge construction (Pellegrino et al., 2001). One formative assessment tool that is often used in constructivist learning is authentic assessment, in which a student is assessed in the perfomance of a task or in finding solutions to real world problems (Brookhart & Nitko, 2018; Nitko & Brookhart, 2011).

The PBL model is an example of a method using the constructivist model. The stated purpose of the Karaman and Celik (2008) study was to examine the positive and negative aspects of PBL and find ways to overcome the negative aspects of PBL. The study used qualitative methods, constructivist theory, and open-ended questions. The major results reported by this study were that 18 of the 29 students felt that PBL was an effective way to learn, 16 of the 29 students thought that there was not enough time to complete the project, and 10 of the 29 students thought the instructor should provide more guidance. The need for more feedback to enhance the learning process and the benefit of the feedback that was received during the project were stressed by several students (Karaman & Celik, 2008). Karaman and Celik pointed out that the sample for this study was quite small and that PBL would benefit from more and larger studies. Feedback and other formative assessment practices have been shown to be effective; however, teachers often have differing views on how to gather and use such information (Karaman & Celik, 2008).

Tinoca and Oliveira (2013) focused on the formative assessment piece of

constructing learning, describing a Formative Activities Plan. In this method, formative assessment activities are a part of a plan that takes the student through a learning project, with feedback points providing information about student learning and progress toward goals. Online tools such as videos, blogs, wikis, and discussions are used as formative assessment vehicles. This feedback is used as formative assessment information to instigate critical reflective practices and identify learning strengths and weaknesses. All this activity results in changes in learning activities as the student builds knowledge toward the learning target. Tinoca and Oliveira stated that further dimensions of feedback need to be studied to create a complete picture.

Similarly, Zain et al. (2016) looked at how formative assessment activities were integrated directly into common learning activities. Rather than treating these activities as separate from the learning process, instructors focused on a seamless method of gathering formative assessment information, then weaving it through learning activities that were flexible, and changed to address the needs of students in constructing learning. Zain et al. implemented the analyze-strategize-implement-evaluate model, which is flexible so that formative assessment can occur, providing information for instructional change that is directed at the specific needs identified in the formative assessment activity. Just as Tinoca and Oliveira (2013) described the use of technology by 81 nursing students at one university in Taiwan to create opportunities for critical reflection and metacognitive process changes, Wu et al. (2012) examined the use of technology to expand on concept mapping exercises. Using digital communication, synchronous feedback was supplied. This created reflective practices that led to learning activity changes and concept acquisition.

Current Practice

Teacher Perceptions of Technology Use in Formative Assessment

      Khanal (2021) examined the use of technological tools to effect distance learning during the COVID-19 pandemic. A study of 81 international students in a BlackBoard Canvas class was carried out to determine student perceptions of online learning during the COVID-19 pandemic. Students had an overall positive opinion of emergency remote learning. The technological tools used for emergency remote learning examined in this study included learning management systems, digital texts, Zoom meetings, online videos, and email. Students viewed the online curriculum positively. However, the view of online collaboration was viewed less positively, but this was because there were less group assignments rather than because of any technological tool. Instructors delivered feedback via email and synchronously during class sessions. Students had a positive perception of real time feedback in class because of the timeliness of the feedback. Students had a positive impression of email feedback when it was delivered in a timely manner (Khanal, 2021).

      A study performed by Martin et al. (2020) examined how teachers perceived the value of differing methods and characteristics of online teaching tools. A survey of 100 teachers examined how the teachers saw the benefit of these methods and tools in four categories: instructor presence, instructor connectedness, student engagement, and learning facilitation. The methods were ranked as helpful or not helpful. The most helpful learning experiences were group projects and peer learning, corrective feedback from instructor to student, discussion boards which were led by students, and personal feedback. Synchronous class sessions were found to be helpful, but only to specific types of instructors. Instructors who find their comfort zone in asynchronous learning seem to

shy away from synchronous class sessions (Martin et al., 2020).

An article by McCorkle and Coogle (2020) furthered this information by describing the characteristics of these methods of teaching and providing feedback that create the greatest success in online learning. The authors described effective email feedback as detailed, specific, and very timely. Text feedback is another method of providing formative assessment feedback to students. Immediate feedback in a synchronous online class is effective as it is close in time to the concepts or skill needing correction. And video feedback allows for multiple methods of intake of corrective feedback, as well as providing an asynchronous method of viewing that provides access and convenience to all students (McCorkle & Coogle, 2020).

Robertson et al. (2019) described some specific characteristics of technology mediated feedback that lead to success. Terms used to describe effective methods of using technology tools to provide feedback include immediate, personalized, accessible, interactive, elaborate, and reusable. In a study of first year undergraduate students in a literacy course in the southwestern United States, Robertson et al. discovered that in order for feedback to be effective, instructors had to create formative assessment activities that students could easily access and complete, and then provide corrective feedback as quickly as possible, with immediate feedback being the most helpful (Robertson et al., 2019).

Teacher Adoption of Technology for Use in Formative Assessment

Teacher perceptions lead to teacher adoption or non-adoption of effective means of gathering and using formative assessment information. During the COVID-19 pandemic, teachers were forced to create online learning environments. This included choosing technological tools that could serve the same purpose as face-to-face techniques

that the instructors were accustomed to using. Tasks such as asking and answering questions, self-learning, and adjusting learning for more effectiveness were now required to be performed at a distance, therefor needing the use of technological tools to accomplish the formative assessment goals for which these activities were taking place (Chandran et al., 2021).

Instructors in a study completed in a university in the Southwest United States examined instructors needs in creating formative assessment activities, utilizing technological tools to perform distance learning. The study examined first year undergraduate students. The data from the study led to the conclusion that technological tools can be effectively used for formative assessment activities and identified some characteristics that led to success. The data suggested that the use of technological tools that had an interface design that student found accessible, and that was affordable, was often successfully used in formative assessment activities at a distance. It was further found that feedback that was personalized, interactive, elaborate, and/or immediate was the most successful at assisting in formative assessment tasks (Robertson et al., 2019).

A study of 16 students in higher education science-technology-engineering-math revealed that, for both instructor and student, acceptance of the use of technological tools in any format, training for both student and teachers is necessary. The study examined Synchronous Computer Mediated Communication it was used to provide digital feedback while students completed group writing assignments. The students used Microsoft OneDrive to share the document involved in the assignment, and to provide feedback directly on the document. Students found this technology helpful in the feedback process (Richards, 2020).

Another study of Synchronous Computer Mediated Communication examined the

perceptions of five teachers of English as a second language through interviews. The teachers reported that students seemed to have a positive view of the specific technological tools being used to provide feedback. Chat was a popular tool for both student to student feedback and for instructor to student feedback. Instructors found Synchronous Computer Mediated Communication to be successful at creating interactions, which is a positive outcome as language learning is more effective as an interactive experience than as a solo, reading experience. Though the teachers had an overall positive perception of Synchronous Computer Mediated Communication, the one thing noted was that appropriate training for both students and instructors was needed for the specific tools and activities to be successful (Udeshinee et al., 2019).

Methods of Accomplishing Formative Assessment With Technology

The current literature examined the many ways that formative assessment information is gained using methods that utilize technology. Mobile learning devices provide feedback to both instructor and student (Soria et al., 2020). Clickers are used for immediate feedback, as well as instructor information on student learning (Asiksoy & Sorakin, 2018). Course management systems (CMS) can be used to supply both synchronous and asynchronous feedback to both student and instructor. Asynychronous formative assessment activites include wikis and group projects, discussion boards, writing assignments, as well as other critical reflection activities mediated in an online setting. Synchronous formative assessment activities include classroom chat functions, meetings, and online class interaction (Khanal, 2021; Simonson et al., 2019). The current literature on these formative assessments was available in a broad variety of scholarly journals and in several fields of education. Many of these studies were of small samples in either specific geographic locations or specific fields of study.

Synchronous and Asynchronous Feedback. Real-time human feedback, rather than face-to-face feedback, was examined in a study conducted among 25 postgraduate students who were forced to receive instruction fully online due to COVID 19. Students found that synchronous, computer-based discussions with the instructor and other students are a positive form of formative assessment. Student perception of virtual classes touched on several points. Virtual classes were seen as more accessible than face to face classes. The characteristics of asking and getting answers to questions, self-learning, and addressing learning needs were very similar in effectiveness between virtual and face to face learning. Students found it easier to pay attention in face-to-face classes. Students expressed a need for both synchronous and asynchronous classes to provide for instant feedback and time for reflection, with material still available asynchronously to review (Chandran et al., 2021). Students reported that they felt the discussions shifted learning from passive to active and that real-time instructor feedback caused a connection between misconception and correction. Both students and instructor reported a more positive experience with computer-based discussions versus face-to-face discussions. The instructor reported more participation in the computer-based discussion as compared to face-to-face discussions (Chandran et al., 2021).

Chain sampling was used to conduct a study of English as a second language classes that used split view on iPad to facilitate synchronous online classes and other educational activities that students would take part in while attending the synchronous online class, such as accessing materials, taking notes, and looking up answers to questions occurring during the class. Students were also able to use smartphones to accomplish synchronous formative assessment activities while in an online class session. A popular application used in split screen mode in this English as a foreign language

class was Google Translate. Students reported that they found that the real-time communication with instructors and immediate feedback were benefits of synchronous classes (Bin Dahmash, 2021).

Some of the available literature examines how synchronous online feedback compares to face-to-face feedback in achieving formative assessment goals. A study of 84 undergraduate students in the biomedical field examined peer feedback delivered face to face and asynchronously online. Students expressed that the greatest results occur with a combination of written peer feedback, followed up by a face-to-face discussion. The written feedback is delivered using technological tools (Schillings et al., 2021). The face-to-face discussion can occur in person or through meeting software. Students in some studies found that virtual meetings were more convenient than face to face in person meetings (Chandran et al., 2021).

Online technology tools have been used more in recent years due to the forced distance learning caused by COVID-19. A study of postgraduate virtual classes illustrated several aspects of student perceptions of virtual classes. Virtual classes were seen as more accessible than in person classes. The characteristic of asking and getting answers to question, self-learning, and having learning needs met were very similar effectiveness between virtual and face to face learning. Students found it easier to pay attention in face-to-face classes. Students expressed a need for both synchronous and asynchronous access to virtual classes. Synchronous access to classes provided for instant feedback. While asynchronous access to virtual classes allowed for review and critical reflection, as well as revision of learning (Chandran et al., 2021).

Some synchronous feedback is delivered digitally, through quiz programs that instantly deliver corrective feedback as mistakes are entered as answers. A study of 176

calculus students in Spain revealed that students who completed quizzes online, and who were provided immediate corrections, scored higher on later exams of the same skills that were included in the quiz programs. Though the researchers noted that it was unknown if the students who completed the quizzes started with higher math skills than those who did not complete the quizzes, the quiz takers had a larger change in skill levels at the final testing point than the non-quiz takers (Figueroa-Cañas & Sancho-Vinuesa, 2021).

Applications were also used asynchronously in this study, as students could rewatch synchronous virtual classes and use tools to take notes, look up translations, or print the power point presentation before the virtual class occurred. Asynchronous formative assessment activities were found to be beneficial because of the convenience of choosing times to watch and rewatch online class sessions, being able to pause, take notes, review, and reflect. Students would watch the virtual class a second time to reinforce the language skills addressed at the synchronous session. This practice was found to improve student confidence in second language skills (Bin Dahmash, 2021).

A comparison of direct, synchronous, corrective feedback to indirect, written corrective feedback was undertaken in a university in Thailand. The participants were six students in preparation (Tatsanajamsuk & Saengboon, 2021) to take the Test of English for International Communication. Though the data revealed that both forms of feedback created some gains in vocabulary and skill, the synchronous corrective feedback created greater gains. When receiving synchronous corrective feedback directly from the instructor, a check for understanding can be made and further, immediate corrective steps can be taken. This action creates individualized corrective feedback that addresses the student learning differences and is more effective at creating gains in vocabulary and skill (Tatsanajamsuk & Saengboon, 2021).

Lowenthal et al. (2020) described experiences in several universities in the United States during the forced online learning era caused by the COVID-19 pandemic. The article highlighted asynchronous class discussions using the programs Flipgrid and EdConnect as being successful in replacing in person class discussions, but also having some drawbacks. Student participation waned over time, and the entries showed less student interest in delving deep into topics. Students used asynchronous video programs lice VoiceThread to create video presentations that were then examined by both peers and instructors. Video feedback was provided by both peers and instructors using screencasts that included audio and text captioned corrective feedback. This was helpful as it was specific and interactive. Asynchronous video feedback was considered helpful for several reasons. Asynchronous video feedback can be easily accessed at convenient times by students on smart phones and other devices. Also, students are able to edit video projects to create a more accurate presentation of their learning gains (Lowenthal et al., 2020)

A study of three mathematics teachers at two schools in Midlands England examined the use of iPads as a tool for delivery of synchronous formative assessment feedback to students. The formative assessment areas addressed with feedback using iPads were determining what students know and building on that, recognizing, and addressing student gaps in concepts and knowledge, and facilitating student collaboration and self-assessment. The iPads were considered a good tool for this process because they gave timely assessment information as well as timely feedback, facilitated interactive learning, and provided a good assessment tracking tool. The iPads were the most useful in working with smaller units of material in a way that led to students and teachers communicating. Teacher and student comfort with the technology also played a role in the success of the iPad use for formative assessment purposes (Dalby & Swan, 2019).

Formative Assessment Engagement was the topic of a study in two phases: one of a medium size classes of about 45 students and one of a large class of about 300 students. The study examined the use of e portal exercises provided by a textbook publisher. These exercises included practice questions, multiple choice questions, select questions, and fill in the blank questions. Students get the results of these exercises immediately. Along with results, students receive corrections, explanations, and links to support material. The results of this study demonstrated that students using this type of formative assessment program experienced high Formative Assessment Engagement, and that students who experienced high Formative Assessment Engagement achieved both high subject mastery and high summative test scores (Schmitz, 2019).

Mobile Learning Devices. Mobile learning devices have provided a convenient and accessible format for the delivery of evidence of learning and feedback for the purposes of formative assessment activities. A study of primary school students in Spain examined the use of mobile devices in English as a second language classes. The study examined 30 students divided equally into three groups: 5 to 7 years of age, described as the lower primary level, 8 to 10 years of age, described as the middle primary level, and 10 to 12 years of age, described as the upper primary level. Students received instruction, provided evidence of learning, and received corrective feedback using mobile devices and the program WhatsApp. Students in the lower primary level felt that images and emojis provided the most information and motivation for correcting their mistakes in English language learning. Students in the middle primary level reported that corrective information in the text format was helpful, but corrective information via images and emojis was more effective for them in reinforcing correct language usage and correcting mistakes. For students in the upper level primary group, the type of corrective feedback

they preferred differed by the type of question they were answering in order to provide evidence of learning gains. If they were answering true/false questions, the older students found emojis and images to be sufficient. However, if the questions were short answer, 40% of the upper level students wanted answers in the text format, and, if the questions were in the long answer form, 70% of the students wanted feedback in the text format (Soria et al., 2020).

A 2019 study of 265 nursing students examined the use of mobile applications on the iPod touch used to gather student learning information and instructor feedback. The applications were used to track the completion of tasks that demonstrate the mastery of needed skills, allowing instructors quick access to valuable information that they can used to adjust learning and deliver feedback to students. Students found feedback from instructor and peer to peer was valuable when it was accessible, in that it provided opportunities for critical reflection and review. The study expressed that though both video presentation of needed information and online assessments were a positive part of the learning experience, students struggled with communicating needed information to instructors. Students also had difficulty understanding the assessment tasks. Training on the applications was needed for both students and instructors for it to be used for the most benefit to the program (Li et al., 2019). A study of 40 English as a foreign language students in Iran demonstrated the importance of vocabulary testing in language learning and examined the use of mobile devices to achieve that formative assessment activity. The results of the study showed that the real-time feedback on mobile device learning applications helped students achieve vocabulary mastery. Students expressed a positive perception of the applications (Yarahmadzehi & Goodarzi, 2020).

Clickers. A similar result was found in a study of student response systems or

clickers. Student response systems are routinely used in undergraduate courses. Students found student response system applications were helpful in starting small-group breakout discussions. The applications also assisted in the formative assessment of the class' understanding of the lecture material. Polling applications may exceed the capability of simple clicker systems by allowing the activity to develop further after the initial response (Kent, 2019). Kent (2019) found a program called Plickers was helpful in adjusting class content in English as a foreign language classes. Using student response systems in that study showed an increase in both teacher student interaction and student to student interaction, which created a very active learning environment (Kent, 2019). Another use of the program was as a pretest and posttest application. This use of student response systems or clickers gives students and instructors the ability to reduce student performance anxiety and to help students have a positive perception of their abilities in the class. Clickers have also been shown to raise student interest in the class material (Asiksoy & Sorakin, 2018).

A similar study looked at using the Plickers application on a smartphone to read Quick Response code cards that students held up to answer formative assessment questions. The instructor then used the information to adjust classroom presentation content to fill gaps in student understanding (Sahin, 2019). A study of 77 students in United Arab Emirates examined the use of the Plickers application to track student progress and adjust learning to fill gaps. Students who used the Plickers application had improved grades. Also, the group that used the Plickers application saw less of a gap between high and low scores. The authors of the study attributed that to greater participation. The Plickers group also were able to cover more material in the same time period as the pencil-and-paper group (Zuhrieh & Sara Abd Al, 2020).

The previous section discussed how instructors use student response systems to perform formative assessment activities. The next section talks about the use of the chat function in CMSs to perform the formative assessment activity of checking student learning and exchanging information.

Chat. Chat includes the chat function in classroom management software synchronous online class software and the text function of mobile device application. Synchronous online classes provide for immediate communication between instructor and students as well as student to student. As timeliness of feedback is essential in learning, and in language learning specifically, immediate feedback in online classes is essential (Bin Dahmash, 2021). The functionality of chat and instant messages allow for communication of feedback using several different formats. Emojis can be used to illustrate the need to seek corrective information in a communication from instructor to student, or confusion and the need for further explanation on the part of the student to the instructor, as a couple of examples of the use of emojis in a chat exchange. Images can also be used to portray corrective feedback in a chat environment. And, of course, text can be used in the chat format to communicate all types of feedback for formative assessment purposes (Soria et al., 2020).

The chat function in an online class, or in any educational interaction provides an opportunity for instructors and students to check for understanding and provide immediate corrective feedback (Tatsanajamsuk & Saengboon, 2021). Students are accustomed to chatting online, and this skill has transferred to using chat as a comfortable method of communicating with instructors. The chat function creates human interaction, an important component of online learning. This, combined with the availability of chat history logs, which can be utilized for formative assessment purposes, presents a picture

of the chat function as an important component of online learning (Udeshinee et al., 2019).

  Group Meetings. Group meetings create critical reflection, which is a key ingredient in learning construction (de Jong et al., 2013). Many programs are in use today in the field of education to facilitate this process, including Elluminate, Adobe Connect, Webex, and Wimba. This software enhances interaction through capabilities for screen and document sharing, as well as synchronous audio, video, and text communication (Martin et al., 2020). Language learning can be aided with audio and video conferencing through the ability to correct speaking errors in real time through both explicit and implicit correction activity. Synchronous correction can be helpful, and the software provides for correction that can be tailored to the individual student (Martin et al., 2020). Immediate feedback and corrections of confusion using Bluetooth technology and webcams was also found to be helpful to preservice teacher education. Positive learning activity changes occurred as formative assessment feedback was delivered (Scheeler et al., 2012). Some students may find that the use of this technology creates some anxiety, which blocks the ability for critical reflection. A study using facial recognition software found that humor helped to relax this tension and resulted in greater learning gains (Lai et al., 2016). Feedback is the way in which formative assessment information can be turned into change in learning activity in both the peer-to-peer and instructor-to-student arena. In real time, it can relate information that causes changes in metacognitive activity due to the evaluation of learning by an instructor. It can also cause changes in learning activity due to critical review and reflection (Scheeler et al., 2012).

  Each of the studies in this section had limitations due to small sample size, limited data collection, and limited geographic diversity. Discussed together, there is a picture of

how formative assessment feedback is being delivered in courses using group meetings that utilize audio, video, and text communication.

Discussion Boards. Another tool used to relay formative assessment feedback through digital means is the online discussion board. Several factors need to be present for online discussion boards to create the formative assessment activity desired. Feedback of formative assessment information on discussion boards needs to address specific learning goals, contain specific types of information, and be presented in the optimal timing scheme for the learning goal Discussion boards can be used by instructors to guide learning or for student-to-student feedback to create the critical reflection step in scaffolding (Mohamadi Zenouzagh, 2019).

A 2020 article examined the use of discussion boards in online classes. The article expressed that two components that were necessary for the successful use of discussion boards were class size and training. If discussion boards are going to be successful in formative assessment tasks, instructors must present clear expectations of student participation in the discussion board activity, as well as timely responses to student questions and needs. Students should be encouraged to create high quality content on the discussion board, rather than a high quantity of posts and responses. Innovations in discussion board activities include the use of audio and video discussions. Discussion boards can be used to deliver positive feedback, timely feedback, critical feedback, constructive feedback, and corrective feedback. Finally, the article states that one of the most important characteristics of a successful discussion board component to a course is student involvement and leadership in the day-to-day function of the discussion board (Page et al., 2020).

A study of 272 participants in a Massive Open Online Course explored the use of

discussion as a method of providing peer feedback. Discussion boards can be a valuable tool in providing peer feedback, but a difference in technical ability of participants can create uneven participation. There are, however, benefits to participating in a discussion board in an online class. Discussion board participants receive valuable peer feedback and a variety of possible solutions to posed problems. Providing feedback to other students creates an opportunity for critical reflection on course content (Elizondo-Garcia & Gallardo, 2020).

The studies in this section, once again, represent a collection of small sample studies that reveal conditions in which discussion boards are used to deliver feedback that leads to formative assessment activities. These results, on their own, may not be generalizable, and further analysis is needed to determine commonalities.

E-portfolios and Blogs. Collaborative online learning also utilizes the critical reflection feedback provided by formative assessment activities. E-portfolios and blogs are popular tools for collaborative learning. A study of 30 teachers in continuing education in Iran examined the effect of implementing two formative assessment assignments and providing feedback on the subsequent summative assessment. The assignments included writing a blog type e-portfolio and posting on E-writing forum (EWF), collaborating with other students, critical reflection on feedback, and revising. The data in this study revealed that teaching students who participated in the formative assessment assignments made gains in content, concepts and the skills being taught and practiced (Mohamadi Zenouzagh, 2019).

A study of 61 students, divided into four cohorts, over a period of 4 years examined the use of e-portfolios, rubrics, and formative assessment activities and the impact on learning outcomes. E-portfolios, combined with a well formed rubric, allow for

peer, instructor, and self-feedback. This leads to critical reflection, and revision of work. This activity, combined with providing peer feedback to other students, creates a situation in which learning goals are met. The four cohorts scored at varying levels on the pre assessment. By the completion of the e-portfolio activity, all four cohorts were scoring in a similar range (Tur et al., 2019).

In a study of blogs written by modern foreign language students on a year abroad program, integration of the formative assessment feedback activity was found to be an important factor in the success of the educational activity. Students were to write up to eight blogs on which they receive peer feedback. The students then choose one blog to develop into a longer blog, incorporating the feedback that has been integrated into the project. The peer feedback is a learning activity in which the student critiquing must align the feedback they are giving to the lesson goals. Students found this activity helpful from both sides (Di Gregorio & Beaton, 2019).

This section described the use of formative assessment in blogs and wikis, much of which is peer feedback. Peer feedback is found in a variety of assignments, as is described in the next section.

Peer Review of Writing Assignments. Peer review, through wikis, blogs, or exchange of writing assignments, has been used as a formative assessment tool. Peer feedback and collaborative assignments have been found to be helpful in constructing learning. This type of formative assessment and feedback has been found to change how work is completed and, often, redirect the learning activity of both the recipient and the contributor (Ebadi & Alizadeh, 2021). Students have expressed a perception that technology provides a good method of performing review activities, reporting the results, and learning from the review information (Schillings et al., 2021).

Peer review and feedback can change how work is completed, thus changing the learning activity to better meet student needs. The peer feedback process causes students to improve reasoning skills and change work habits to better accommodate the peer review process. The revision of work leads to a revision of learning. Students have expressed a preference for a digital communication of peer review information, as tools to act upon the review are built into the process (Ebadi & Alizadeh, 2021). According to Ebadi and Alizadeh (2021), the most effective peer feedback points out problems, asks questions, and gives suggestions to correct problems. The study included 40 adult students in Iran completing an English course meant for learning English for the purpose of immigration to an English-speaking country. Students wrote draft papers, received peer feedback, revised paper, received instructor feedback, performed a second revision, and completed the paper. Blogs and wikis were utilized to gather peer feedback and perform revisions. Peer feedback must be monitored by instructors, as weak academic writing skill has been found to correlate with weak review skills. It is usually a good idea to have multiple sources of peer feedback, as this seems to change student-writing processes, causing metacognitive changes. These changes account for a rise in the ability to self-review writing. Completing the circle, better writers give better peer review information to peers (Ebadi & Alizadeh, 2021).

A study of 130 seventh-grade students in the Midwestern United States examined Adaptive Comparative Judgment, a method in which students receive formative assessment feedback on design projects from both peers and instructors (Bartholomew et al., 2019). The students designed travel brochures and were assessed based on rubric criteria. Students could use the feedback to revise their work to greater meet the assignment requirements. Student perception of this process was positive and found that

both giving and receiving feedback was valuable to achieving a good result on the assignment. Students who were involved in the Adaptive Comparative Judgment process scored higher on the final assessment than those who were not involved in Adaptive Comparative Judgment (Bartholomew et al., 2019). Similarly, in a study of undergraduate biochemistry students, formative assessment groups were utilized to deliver video feedback to assist student self-assessment (Simpson et al., 2019). The peer feedback was found to be positive when it was interactive, in the form of giving and receiving information, and students felt capable of assessing their peers' work as the semester went on. The only drawback encountered was a tendency for superficial feedback from some peer participants (Simpson et al., 2019).

The studies described in this section point out characteristics of peer review that contribute to formative assessment activity. The studies in this section all reported limitations related to small sample sizes and specific characteristics as targets of investigation. The next section presents similar information about feedback from instructor to student.

Instructor-to-Student Feedback. Instructor feedback is obviously helpful in relaying the formative information necessary for constructing knowledge (Robertson et al., 2019). A study of the effect of technology mediated formative assessment feedback on the perceptions of 114 undergraduate students toward participation and success in a course. The characteristics of technology mediated feedback identified by students as leading to successful outcomes are immediacy, personalization, accessibility, and reusability. Students also preferred elaborate feedback and feedback that involved interaction (Robertson et al., 2019). McCorkle and Coogle (2020) described technology tools that create success in the use of technology mediated formative assessment

feedback. Email feedback that is detailed and serves a specific purpose is described as creating successful revision of work and learning activities. Text feedback can be used to provide observations on a performance based activity. And vide feedback is often used for instructor and peer reviews of student work (McCorkle & Coogle, 2020).

Both video learning tools and audio learning were found to be helpful in formative assessment and feedback activities (Henry et al., 2020). Video learning tools are useful in gaining formative assessment information, as well as in the delivery of feedback to the student. Digital video assignments can be marked at certain sections, allowing formative assessment information to be added to pinpoint learning changes that need to occur. One specific method of providing audio visual feedback is to use screencasts. Screencasts allow the feedback provider to add audio visual feedback to screenshots of student work. Screen casts have the advantage of providing frequent feedback, detailed and personalized to each student, that can be viewed at the student's convenience (Henry et al., 2020). Other types of asynchronous video feedback provide similar benefits to screencasts. Asynchronous videos can be viewed on mobile devices at times convenient to students. Using the feedback gained in video feedback, students find they can more accurately present what they know and can do. Asynchronous conversations can also lead to feelings of being connected in an online course, which is a characteristic that is sometimes missing in distance education (Lowenthal et al., 2020)

Other instructors prefer to provide synchronous computer mediated corrective feedback (SCMCF). A study of teachers' perceptions of SCMCF was examined in a study that analyzed interviews of five teachers of English as a second language. The teachers stated that they used SCMCF to provide corrective feedback to students, creating SCMCF. The reasons instructors chose this method of providing feedback for students

were that students enjoy technological activities, especially chat activities. Students enjoy both instructor student communication in chat, and peer to peer chat communication. SCMCF creates an interaction, and in language learning, interactive learning works better than simply reading content. There are obstacles to SCMCF. Instructors must be trained in the correct use of the tools utilized in providing computer mediated feedback. The technology used to deliver feedback is not evenly available throughout all learning institutions. Teachers have raised concerns about heavy teacher workloads precluding training time, as well as worries about boundaries online if social media is involved in the computer mediated feedback (Udeshinee et al., 2019)

Digital feedback received directly by the learner can also influence learning activity. Students in a calculus course who took online quizzes with immediate feedback scored higher on later exams testing the same skills and knowledge than students who did not participate in the online, formative assessment quizzes. It was noted, in this study of 176 students, that students who were inclined to use the quiz program, may have started with a higher level of math skill than students who did not choose to take the quizzes (Figueroa-Cañas & Sancho-Vinuesa, 2021).

Qualitative Content Analysis

Introduction

Qualitative Content Analysis (QCA) is a method of answering the research questions of a study. The research questions refer to the process of formative assessment that is accomplished using instructional technology. QCA asks several questions about this process. QCA is a method that examines how this process of performing formative assessment using instructional technology is defined and how this process develops. QCA is a way to examine changes in process and the consequences of a process occurring

through an examination of data. The process of QCA occurs through the development of a coding frame. One method of building a coding frame is to take information from different sources that would answer the research questions and divide it by topic. The topics become domains or categories, generally organized around the answers to the research questions (Mayring, 2019).

Taxonomic analysis is a qualitative research method that involves the creation of domains showing the range of concepts that are found in studies that address the research questions. The taxonomies, or domains, lay the basis for further qualitative analysis such as constant targeted comparison and imported concept synthesis. Taxonomic analysis can be used to show causation, to illustrate functional relationships, and to show rationale. Constant targeted comparison, in which the researcher identifies similarities and differences in the data as related to the research questions, was the primary qualitative analysis method used in this study (Zong et al., 2020).

In this study, QCA was accomplished using taxonomic analysis methods by analyzing the available information using a coding frame. The coding frame is built using a representative sample of the material that will be analyzed to find answers to the research questions. The material should include examples of the whole that represent each category that will be present in the coding frame. However, the coding frame build should not use all the material available for analysis. Coding frames can be changed if new material is found that represents a new category (Zong et al., 2020). After data were placed into categories or domains, taxonomic analysis and constant targeted comparison methodologies were used to synthesize the data from various studies. This data synthesis resulted in answers to the research questions posed in this study. Constant targeted comparison is a method of identifying and exploring various studies to find both similar

and disparate data. The result of this comparison creates a new data set that can express a synthesis of the data from several studies (Creswell & Creswell, 2017).

A good example of the QCA process was used in examining individual medical decision-making processes. A study was undertaken to gather information on the opinions and processes individuals went through in forming opinions about medical decision making, using a case widely reported on in the press as a focus point. The coding frame was built using categories suggested by the research questions and driven by the data collected from the participants. Participant opinions were sought, and those opinions were used as categories with which to examine the decision-making process. Priority was given to those categories that directly related to the research questions of the study so that the main categories were the most closely related to the research questions (Zong et al., 2020).

Rationale

Formative assessment is a necessary tool of educators; however, teachers struggle to overcome the barriers to implementing this practice (Kim et al., 2019). Formative assessment is especially important in learning environments employing PBL to accomplish the goals outlined in the constructivist and scaffolding theories of education. Investigations into these barriers suggested that technology might be helpful but recognized that available studies were small and further study was needed on other populations (Khanal, 2021; Robertson et al., 2019). Hardware such as mobile devices, handheld computers, and clickers were found to be useful, but difficulty in integrating these into classroom use posed a problem (Asiksoy & Sorakin, 2018; C. Li et al., 2017).

Digital assessment records and authentic assessment assignments such as e-portfolios provided instructors with information valuable in formative assessment (Tur et

al., 2019). With all technologies to be used for formative assessment, it is important to affect full integration into curriculum, and this is done best in classes with student-centered philosophies (Gündüz & Akkoyunlu, 2019). Formative assessment is needed for effective student learning, as it gives instructors the information they need to gage the effectiveness of instruction strategies, and to change those strategies in appropriate ways if needed (Brookhart & Nitko, 2018). The literature discussed shows the beginning of understanding of how formative assessment, aided by technology, can influence classroom practices. To reach any level of integration of these and other solutions, formative assessment use and value must be understood, and negative perceptions must be overcome. A content analysis of the appropriate studies accomplished this goal (Simonson et al., 2019).

Research Questions

A content analysis of appropriate studies was conducted to answer the following three research questions.

Research Question 1

What specific technology tools and developed formative assessment resources are being used by the teachers?

Supporting Question 1.1. What similarities exist in reported findings about assessment resources currently in use by instructors and students in various educational settings?

Supporting Question 1.2. In what ways do reported findings show differences in assessment resources currently in use?

Subquestion 1.2.1. What differences in success and failure are reported in the use of technological tools in formative assessment activities?

Subquestion 1.2.2. What are those differences?

Research Question 2

What formative assessment information do the teachers gain as the authentic assessment activity is carried out?

Supporting Question 2.1. What is the reported target of the assessment resource being studied? (Example: Skill construction, Concept acquisition, or Content acquisition.)

Supporting Question 2.2. What is the impact of the target on the ongoing learning process? Does the student achieve the target goal?

Research Question 3

How are teachers using the formative assessment information gathered during assessment activities utilizing technological tools to improve learning experiences?

Supporting Question 3.1. Does the assessment target information lead to new teaching and learning activities?

Supporting Question 3.2. Does the assessment target information lead to changes in ongoing activities?

Supporting Question 3.3. Is integration of the assessment target information part of the goal of the learning activity?

Conclusion

This study examined technology use in formative assessment through the lens of scaffolding theory. Different technology-mediated formative assessment activities that are commonly seen in PBL lessons were examined through a QCA of existing studies of those methods. The literature available investigated technology in use by both teachers and students in the process of formative assessment, as well as many methods of formative assessment in which technology is utilized.

Chapter 3: Methodology

Introduction

In this chapter, the methodology used to conduct this study is explained. The aim of the study is described, and the qualitative research approach is detailed. This chapter provides details about the procedures and data collection tools used in this qualitative research analysis. The method of data analysis is described in this chapter. Finally, this chapter describes methods used to assure the ethical considerations, trustworthiness, potential bias, and limitations of the study are addressed.

Aim of the Study

This study used content analysis to assemble and analyze data from the relevant studies that have been conducted regarding formative assessment, and how teachers use technological tools to assist in performing formative assessment activities. Content analysis, as a research method, allows the researcher inductively explore inconsistencies, as well as relationships between findings in various studies. It is a method of retrieval of, and demonstrating relationship among, the data gathered on a topic or question that is both systematic and comprehensive (Mayring, 2019). This method allows the researcher to classify, code, and compare information. Schreier explained that content analysis allows the researcher to explore inductively inconsistencies, as well as relationships between findings in the various studies.

Qualitative Research Approach

Introduction

Qualitative Content Analysis (QCA) is a method of describing qualitative material using systematic classification and a well-designed coding frame. QCA is used in studies

that are interpreting rich data sources to compile and compare verbal and visual data. QCA can be effectively used on data collected from various completed studies when that data is compiled using systematic data collection practices. QCA then uses a coding frame, developed from the data, to compare and analyze the collected data (Mayring, 2019).

Study Selection

Studies were collected and analyzed as the main data source. The criteria for study selection involved four major categories: topical, population, temporal, and methodological. Each study must meet the topical criteria of having data that pertain to the themes in the list and to the research questions. The population parameter was very broad for this study in that it included almost anyone who is involved in education. That is, studies were included that examined phenomena that occurred in kindergarten to Grade 12 education, postsecondary education, and graduate education. The population using the information obtained for formative assessment purposes included instructors, tutors, coaches, and students. Training programs in the business world were not examined.

Studies that examined phenomena among students and instructors were included. Studies were limited to the period between 2017 and 2022. If studies that were more recent became available, they were included. Methodology used in the studies was looked at only in terms of the data that were generated by the study. In order to be included in this analysis, each study had to provide observed data that were qualitative in nature or quantitative data that were sufficiently interpreted to be included in the comparisons. In order for the information to be useful in this synthesis, it needed to be either an explanation of the phenomena or a description of a phenomenon (Zong et al., 2020).

Participants

There were no participants in this study. Studies that were examined included educational activities which occurred in settings serving students from kindergarten to grade 12, postsecondary, graduate, and adult education. The population using the information examined in this study included instructors, tutors, coaches, and students.

Data-Collection Tools

Searches were driven primarily by topic. Topic-driven searches arose out of the research. The topics that were searched included formative assessment and technology, filtering for teacher perception, teacher adoption, and methods of accomplishing formative assessment using technology. Under the methods section, searches were made for mobile learning devices, clickers, digital feedback, and CMS software. Under the digital feedback heading, searches were made for synchronous feedback that included chats, classes, and meetings. Under the same headings, searches were made for asynchronous feedback such as critical reflection, wikis, and discussion boards. Some of these topics intertwined. For example, a study of CMS software might include subsections on synchronous or asynchronous feedback (Bin Dahmash, 2021; Mayring, 2019). Searches were performed through several databases and indexes of peer-reviewed journal articles and dissertations. The databases and indexes that were searched can be found in Appendix A.

Procedures

Introduction

This flexible and systematic method, QCA, uses a set of procedures to turn data into meaningful descriptions of processes (Mayring, 2019). Schreier pointed out that research questions are developed, leading to the selection of material from which data

will be gathered and that an initial examination of a representative selection of that

material will be used to build a coding frame. Schreier then directed that the material

should be divided into coding units. The coding frame was applied to the material in a

trial run. The trial run was evaluated to indicate modifications to the coding frame, if

needed (Mayring, 2019; Zong et al., 2020). The coding frame was then applied to the

whole of the material gathered. The results of the coding assisted in the analysis, which

was then interpreted for a final report in which the findings were presented (Mayring,

2019; Zong et al., 2020).

Four parameters were used to determine eligibility of research studies to be

included in this qualitative content analysis: topical parameters, population parameters,

temporal parameters, and methodology parameters. Studies must have, as subjects,

members who fit into one of three categories: kindergarten to Grade 12 students,

postsecondary students, and the instructors of these students. The studies needed to have

been conducted between 2016 and 2022. The methodology of the study needed two

important characteristics. Studies needed to have a purposeful standard and meet the

interpretive requirements of qualitative research (Creswell & Creswell, 2017).

The most extensive area of criteria involved topical parameters. All studies

examined some phenomena of formative assessment practices that utilized technology in

their implementation. The technologies used in these practices included mobile learning

devices, clickers, and digital feedback. Digital feedback could cover synchronous

feedback such as CMSs and communication software, as well as asynchronous feedback.

Asynchronous feedback could include feedback between instructors and students or peer

to peer. This could be accomplished through wikis, group projects, or discussion boards.

Data-Collection Process

Data collection occurred according to a taxonomic analysis process. This process used inductive reasoning to synthesize classes of data (Zong et al., 2020). Data were collected from a variety of studies that might have used interviews, observations, documents, or artifacts, to explain or describe a phenomenon that was targeted by this study. For this study, domains or themes were discovered according to the research questions and answers found in the data. Data that met the criteria defined in those domains were selected and placed into those domains to be compared and contrasted with data in the same categories (Zong et al., 2020). The domains included teacher perceptions of technology use in formative assessment, teacher adoption of technology use in formative assessment, and methods of accomplishment of formative assessment utilizing technology.

Within the methods domain, information was organized into sections about synchronous interactions, asynchronous interactions, peer-to-peer interactions, and instructor-to-student interactions. Within these categories, techniques of formative assessment and the resulting information gathered and applied to learning were examined. This information was placed into three thematic sections that followed the research questions of this study. Data about the formative assessment information that teachers gain as technology-assisted formative assessment activities are carried out were gathered and synthesized. Data about the effects of digital feedback on both learning and teaching activities were analyzed.

Qualitative Content Analysis

Coding Frame

A coding frame was constructed to organize the data being examined into categories that revealed the relevant information within the data that would answer the

research questions (Mayring, 2019). The coding frame met several requirements. A good coding frame is unidimensional, which means that each dimension within the coding frame relates to just one characteristic of the data. Subcategories within the frame are mutually exclusive. Subcategories are both exhaustive and saturated. Each coding unit only fits one subcategory within the frame, and each subcategory has at least one unit fitting into it (Mayring, 2019).

The coding frame for this study had a data-driven structure. The data from completed studies were examined and sections were isolated and paraphrased, removing extraneous material, and then matching similar sections and compiling them into themed sections. Those sections then became a themed category or subcategory. Categories were formed that represented unique concepts and were used to identify both similar and contrasting information (Mayring, 2019). A sufficient, but not exhaustive, amount of material was used to test the coding frame. Additional categories and subcategories could be added if needed (Mayring, 2019). The categories and subcategories of the coding frame were developed according to a set of rules. Categories were defined using a name, a description, and examples. The description included the specific characteristics of that category that indicated the presence of the phenomenon being studied and the data that would relate to the research questions. Examples, along the same lines, should indicate the phenomenon and relationship to the research questions (Mayring, 2019).

Coding Pilot

After the coding frame was developed, trial data were applied to the coding frame. The categories and subcategries were examined for mixed dimensions or overlapping. If there was sufficient overlapping, categories were either collapsed or combined. If the overlapping was not significant, or the differences between categories

were distinct, categories were kept separate (Mayring, 2019).

Final Coding Frame

A final coding frame was developed from the coding frame build and adjusted through the coding frame pilot. The final coding frame contained a main category, which indicated the aspect of the data that related to the research questions. It also contained subcategories that revealed the information contained in the data showing the characteristic in the data that answered the research questions (Mayring, 2019).

Data Analysis

The final coding frame was applied to the data culled from the studies being analyzed. The data were orgainized to identify the relevant data. Each study was a unit of analysis. Coding units were identified within the units of analysis and placed in the appropriate categories and subcategories for further interpretation (Mayring, 2019). A thematic criterion was applied to the coding units to assist in the description of the state of the data, which, in turn, answered the research questions (Mayring, 2019). NVivo software was utilized and applied to the units of analysis, both marking and coding units at the same time. This resulted in a segmentation of the material being coded into units that could then be placed into the categories in the coding frame (Mayring, 2019). NVivo assisted in identifying and organizing data to recognized similarities and differences within the research findings available in the current literature. The resulting findings were compiled and analyzed to answer the research questions of this study.

Ethical Considerations

Creswell and Creswell (2017) described factors for ethical data collection and reporting. This study used data collected in other studies, and that data must be reported as found originally, not altered to meet any bias in the researcher. All material gathered

for this study needed to be represented accurately and credited to the source. Finally, there was an ethical imperative to use high-quality research methods and report the practical significance of research.

Trustworthiness

Trustworthiness was accomplished through assuring reliability and validity in the methods and conclusions of the study. Reliability is a term that describes data that are analyzed in a coding frame that is error free and yields analysis that is repeatable and consistent (Creswell & Creswell, 2017). Validity describes the extent to which the study answers the questions the study asks through categories that are representative of the concepts to be studied (Creswell & Creswell, 2017).

Reliability

The first element of trustworthiness, reliability, was achieved through a specific set of methods. The first method was multiple coding of selected material. As this study involved a single coder, the material must be recoded at different times. Consistency between coding instances was examined, assigning a coefficient of consistency by dividing the number of coding agreements by the total units of coding. Incidents of low consistency needed to be examined to determine if the problem was within the coding frame or if the material was not being interpreted appropriately (Creswell & Creswell, 2017). Reliability problems that occur because of problems with the coding frame can be addressed in a few different ways. The coding frame should be well tested before use to minimize reliability problems. Category terms should be highly standardized to maximize consistency within a study. Consistency errors do occur, however, and would be explored and explained (Creswell & Creswell, 2017)

Validity

Validity is another factor in the trustworthiness of a study. The validity of a study describes the extent to which the study addresses the purpose of the study, by answering the research questions. There are three aspects that can be used to examine the validity of the study and conclusions found within the study: face validity, criterion validity, and construct validity (Mayring, 2019). This study used appropriate means to achieve these validity goals. Face validity describes the extent to which a study will measure what it claims to measure. Criterion validity examined the analysis described in this study to indicators described in studies where the validity was already established. Construct validity describes the relationship between the process or idea being studied and other concepts. Examination of construct validity is only needed if the study expresses inferences beyond the research material (Creswell & Creswell, 2017; Mayring, 2019).

This study employed various methods to examine and achieve validity. The study used concrete thematic indicators to make sure interpretations achieved a high level of validity. The scope of inferences was limited to the expressed meaning of the material and external validation was applied, when necessary and available. The content of the study was taken directly from the material being studied, and the descriptions of that content were highly standardized. Latent content, in which interpretations of the content of the material were made, was limited. If a high coding frequency in the miscellaneous category, or in one subcategory versus other subcategories, occurred, the coding frame was examined and adjusted (Mayring, 2019).

Potential Research Bias

Research bias occurs when the researcher allows prior assumptions or attitudes to change the analysis of the data in such a way that it no longer accurately reflects the state of the phenomenon. Several research practices within QCA help to keep any biases out of

the analysis. First, using descriptions that are as accurate as possible, without identifying subjects, helps to alleviate any bias in the data and responses within the study. The coding frame in this QCA also reduced bias in reporting and analysis. A coding frame with appropriate categories for analysis organized the material clearly to help reduce the effect of any researcher background or assumption bias (Mayring, 2019).

Limitations

This study was limited to the convenience samples that have been studied in the past to answer the research questions. Technology has and will continue to evolve quickly and be implemented in classrooms in different ways. This could create different results and different conclusions than were found with the data currently available.

Conclusion

This study was a content analysis of existing research that focused on technology use in formative assessment. This involved a qualitative research approach that described methods currently in practice, comparing studies to glean information about these practices. This QCA helped to organize existing data into units of analysis that would answer the stated research questions to provide a clearer picture of current uses of technology in formative assessment.

Chapter 4: Results

Introduction

Qualitative Content Analysis (QCA) was used to gather the data from studies addressing technology use in formative assessment and to analyze those data to create a picture of how instructors were using technology to carry out formative assessment activities, online and in the classroom. QCA is helpful to answer questions about this topic in that a large number of studies exists across various demographic and topical areas. The similarities and differences found in an examination of the results found in 189 studies and articles created a description of practices available for use in conducting formative assessment tasks. In this study, themes were created in answer to the research questions that arose from the literature review. These themes were studied in relationship to common methods that became apparent in a reading of the documents in the literature review. A coding frame was built using these methods as nodes to create a comparison of similarities and differences within the theme, and to describe how the methods are commonly used.

Data Collection

This section reports the method used to find and collect data that provide information that will answer the research questions. In this section, the themes that were revealed in the database searches are revealed. The tools that instructors and students are using to accomplish formative assessment tasks are discussed in this section arranged by theme, as well as within the temporal aspects of asynchronous and synchronous activity. This section, ultimately, describes search methods used to identify studies that contain sections describing the searched terms, allowing for the identification of topics that answer the research questions of this study.

A search of the databases listed in Appendix A of methods related to technology use in formative assessment to answer the research questions on teacher perception, teacher adoption, and methods of accomplishing formative assessment using technology yielded 682 documents. To identify studies related to the methods question, documents were found by searching using the terms mobile learning devices, clickers, digital feedback, and CMS software. Digital feedback searches led to searches for synchronous and asynchronous methods of communication. Topics arising out the synchronous label include chats, class sessions, and meetings. Topics arising out the asynchronous label included wikis, critical reflection, and discussion boards. The articles and studies found were further examined for inclusion in the analysis performed.

Studies were included if they were published within the last 5 years, were directly related to the topic of technology use in formative assessment, and if they were reporting the results of a study on any of the various methods of using technology to perform formative assessment tasks. Articles were excluded from analysis if they were more than 5 years old, unless they were found to be uniquely suited to this study. Articles and studies that were not closely related to a study, or that were a set of observations that related to a compilation of studies were not included for analysis. Studies that did not present any information that related to one of the three research questions were also excluded from analysis. There was a total of 493 documents excluded from this study for the above reasons.

Coding Frame Pilot Test

This section describes the coding frame test that was used to discover the main theme for topic organization of the data used in this study. This section also discusses the methods used with the coding frame test to identify levels of subcategories used to

describe the answers found in the data to the research questions in this study. The coding frame was tested using 20 articles listed in Item 1 in Appendix B. The 20 articles were searched for the terms: chats, class sessions, meetings, critical reflection, wikis, discussion boards, CMS software, mobile learning devices, and clickers. The search results were then examined to determine which instances of the appearance of the term had context that related to the research question. That context was then recorded at the node.

As a result of the test of the coding frame, it was determined that digital feedback would be a main theme under which topics would be organized (see Item 2 in Appendix B). The next level subcategories used were synchronous and asynchronous feedback. Under those headings, the specific methods and tools used to perform formative assessment tasks using technology were examined. CMS software, mobile learning devices, and clickers remained themes directly related to the formative assessment in technology topic.

Articles Analyzed

This section describes how NVivo was used to isolate sections of the included studies to investigate the data that were relevant to the research questions in this study. This section also explains how NVivo was used to analyze the included sections by word frequency and identifying the terms that would be used to search for relevant data. The 189 articles that were deemed appropriate for analysis were uploaded into the NVivo program. These documents were analyzed using the NVivo program tools to identify and isolate the descriptive context of the themes mentioned above. The results and discussion sections of these studies were isolated and searched for the terms in this study. Of these documents, 176 had discussion sections and 150 had results sections. Study data from a

total of 189 documents were represented in this study by a results section or a discussion section or both. A query of word frequency in these isolated sections guided the subsequent queries of themes found within these studies that would answer the research questions. The context provided by searching the terms these studies had in common provided the further terms and themes to analyze in order to answer the research questions.

Word Frequency

A word frequency query showed that the term *feedback* was the most commonly occurring theme in the results and discussion sections of the include studies. While word frequency can help identify themes, a theme word may appear many times in one study alone, thus creating an appearance of significance that may not be warranted. For that reason, the terms that were used frequently were also searched to determine the number of studies in which they appeared.

Searching Theme Terms

This section describes how data were found by search theme terms that were identified by work frequency searches, including searches for synonyms and related terms. This section also describes the methods used to retrieve data and choose and code those data within the NVivo tool. An initial search was made for the term *feedback*, including synonyms and related terms. Feedback is an umbrella term for many of the other themes found in these studies that answer the research questions. The feedback search provided excerpts with data that helps answer each research question and sub question at varying levels. The themes of class sessions and critical reflection were searched for exact matches within the selected text. The terms *asynchronous*, *synchronous*, *chat*, *email*, *meetings*, and *wikis* were searched to include synonyms. The

term *discussion board* was searched for matches to include stem words. The themes of CMS software and mobile learning devices were searched as separate umbrella themes, but they were still related to the theme of feedback.

The material surrounding the terms found was examined to determine if it provided any contextual clues to help answer the research questions. If relevant contextual information was found, it was saved and coded to the research question and sub question to which it was related. The context was also recorded if it showed any reaction to the method that participants displayed, including the success or failure of the method to accomplish the stated goal, the impact the method had on the learner's self-view, the impact the method had on learner motivation, and other topics as they presented themselves.

The above sections described this QCA study that was used to gather data about technology use in formative assessment. Similarities and differences of methods and tools were examined revealing themes that allowed for the creation of nodes in order to answer the research questions. Data were collected by searching databases to identify studies that related to the research questions. Key terms that represented the themes that revealed themselves in the previous section were searched to enable identification and analysis of the data. The terms that were found most often were mobile learning, clickers, digital feedback, and CMS software. Many studies organized or presented data split into the categories of asynchronous feedback and synchronous feedback. Synchronous feedback covered such topics as chats, class sessions, and meetings. Asynchronous feedback included such tools and methods as wikis, critical reflection, and discussion boards. Studies were excluded if they did not provide data to answer the research question or if they were not timely. Articles were analyzed using the NVivo program to identify and

isolate content that would answer the research questions related to the themes using word frequency and word search functions. The data were then coded at theme nodes listed under the research question addressed. Some passages related to more than one research question.

Themes Generated in Studies Selected for Research

This section discusses the way in which results were generated for this study by examining data with queries on targeted terms related to formative assessment tasks accomplished using technology. This section describes the method of locating data, as well as illuminating the data found that were relevant to the research questions in this study. The results and discussion sections of the studies selected for this research were queried on the terms feedback, asynchronous and synchronous, discussion board, meetings, class sessions, critical reflection, chat, email, and wikis. Each occurrence of the theme term was examined at the sentence level to determine if the resulting material provided any answers to the research questions. If relevant material was found, it was coded at the specific research question the data addressed to be considered alongside the results of other themes revealed through taxonomic analysis.

The term *feedback* was found in 140 of the 189 studies. The 2,562 occurrences of the term feedback were analyzed, and 879 segments were initially assigned to the research questions which the data addressed. Two terms related to feedback also appeared in many of the studies, with asynchronous appearing in 64 documents and synchronous appearing in 49 documents. More specific terms revealed themselves as themes in this study (see Table 1). Discussion boards appeared in 179 documents, meetings appeared in 175 documents, class sessions appeared in 139 documents, critical reflection appeared in 107 documents, chat appeared in 56 documents, email appeared in

49 documents, and wikis appeared in 11 documents.

Table 1

Theme Word Occurrences in Selected Studies

_____

Theme	No. occurrences in selected text	No. files in which term appears
Asynchronous (with synonyms)	548	64
Synchronous (with synonyms)	727	49
Chat (with synonyms)	544	153
Class sessions (exact wording)	2,066	139
Critical reflection (exact wording)	1,209	107
Discussion board (with stem words)	4,209	179
Email (with synonyms)	499	44
Meetings (with synonyms)	3,181	175
Wikis (with synonyms)	53	11

_____

Results for Research Question 1

This section records the results related to themes that the data revealed. This section discusses the data in relation to which technology tools and developed methods instructors and students have used to perform formative assessment tasks. Specifically, this section describes the findings that are relevant to the first research question of this study in the form of a list of the tools and resources used by instructors and students in tasks that discover learning deficiencies and formulating and carrying out corrective actions. The discussion of these findings is organized first under the term feedback. The feedback section discusses the number of segments identified and analyzed to reveal data related to the term feedback. It describes the nature of the documents in which these data were found and how these data were classified. It also describes the characteristics of feedback that the data revealed.

This section then discusses the data returned under the theme of asynchronous and synchronous communication. The temporal subsections describe the relationship of the

temporal characteristics of formative assessment communication to the quality of the communication. The frequency of the temporal terms in the chosen segments is discussed in this subsection, as well as short descriptions of the technological tools revealed as useful for formative assessment activities. Further subsections of this section discuss the data found relating to the use of discussion boards, chat functions, email, and wikis as a part of formative assessment activities.

Frequently occurring themes answer the question: What technological formative assessment resources are being used by the teachers and students? The findings for these themes were identified by a query of a key term on the discussion and results segments of the selected studies, which were then examined at the sentence level to determine which research question, if any was addressed. Those results were then searched for word frequency to determine next examination steps. The most frequent terms were then searched to determine what data those passages can provide to answer specific research questions in this study.

Findings coded at Research Question 1 provide a list of technology resources (i.e., the tools and methods) that instructors and students in the studies are currently using to accomplish the formative assessment tasks of assessment and corrective action. Findings coded at Supporting Question 1.1 give a description of those resources. Findings coded at Supporting Question 1.2 show an analysis of those resources in comparison to each other. Findings coded at Subquestion 1.2.1 list the differences in success, failure, and difficulty of use of those resources. Findings coded at Subquestion 1.2.2 analyze those differences.

Feedback

There were 469 segments found that, through the examination of the context surrounding the term feedback, provided information relating to all questions included in

Research Question 1. Analysis of those segments excluded segments that were not

original research or did not specifically answer the research questions, leaving 414

references that were applied to the research questions. The data were classified by which

section of Research Question 1 that it addressed and by the specific term themes that

have been identified. For Research Question 1, 150 segments from 62 studies answered

the research question in general, providing information about what technology tools and

developed methods are being used by teachers and students for the purpose of formative

assessment activity. See Appendix F.

These segments were queried for word frequency to determine areas to examine

further. There were two main types of themes appearing in the data: technology resources

used in formative assessment and activities carried out for formative assessment

purposes. The specific term feedback was a major theme that occurred 108 times in the

segments studied at this node. The characteristic most mentioned were the timing of the

feedback. Methods of feedback delivery also appeared frequently in the sections coded.

The most mentioned methods were written feedback, audio feedback, and video

feedback. Three forms of written feedback were present in many of the studies. These

were email, discussion board responses, and peer review of essays. The source and target

of the feedback was also a prevalent theme. Sections relating to peer feedback and

instructor feedback were prevalent in the included studies. Peer-to-peer feedback and

student to instructor feedback appeared in the assessment portion of activities. Peer-to-

peer feedback and instructor-to-student feedback was often a part of the change in

learning activity portion of formative assessment in the studies.

Feedback characteristics in order of frequency of appearance in included studies

were as follows: (a) Feedback (Uncharacterized), (b) Peer feedback, (c) Asynchronous

feedback, (d) Synchronous feedback, (e) Instructor feedback, (f) Video feedback, (g)

Audio feedback, (h) Corrective feedback, (i) Immediate feedback, (j) Constructive

feedback, (k) Personalized feedback, (l) Timely feedback, and (m) Written feedback.

Other activities that were technology assisted in the formative assessment process were

identified in the studies being examined. Discussion group activity was the most

commonly identified. Collaboration activities were the next most commonly examined

activity that had a formative assessment component built in and were performed with the

aid of technology tools. Other common formative assessment activities, or activities with

a formative assessment component that appeared in the included studies were chat, blogs,

peer review, revision, critical reflection, and self-reflection.

Software, applications, hardware, and functions of programs were frequently

occurring themes in explanations of how technology is used to accomplish formative

assessment goals. Learning management systems and CMSs, in general and as named

systems, such as Blackboard, Desire2Learn, Massive Open Online Courses, Schoology,

and Moodle, were frequently examined as formative assessment tools (Crane, 2017;

Gafni et al., 2017; Hojeij & Hurley, 2017; Hurtado, 2017; Schmitz, 2019). Collaboration

and communication software, such as Online Meeting and Skype, were also in the list of

frequently mentioned tools. Social media and learning, such as Facebook, O.W.L.,

Blogger, and Wikispaces, appeared in several studies (Bin Dahmash, 2021; DeMara et

al., 2019; Ebadi & Alizadeh, 2021; Hegarty & Thompson, 2019). Two multiple use

resources were Google tools and Microsoft Word functions, which both instructors and

students used for collaboration, feedback, and revision (Bin Dahmash, 2021; Hegarty &

Thompson, 2019). A complete list of occurrences of activities as topics of the study

segments and their sources examined in this qualitative content analysis can be found in

Appendix C.

Blackboard Learn components, which were examined in nine sections of six different articles, were studied separately. The live classroom functions are contained in the Blackboard Collaborate component of the platform. Within the Collaborate classroom, the functions of audio and text chat, as well as document sharing, and the raise hand function are used for formative assessment activities (Crane, 2017; DeMara et al., 2019; Olesova & Melville, 2017; Vasquez, 2017) The Blackboard discussion board was also discussed in several of the studied sections as a tool for formative assessment activity (Radoli, 2017). Fifty segments from 23 studies provided answers to the research question along a specific theme. These segments were then examined to identify methods and resources that have the characteristic described by the theme.

Asynchronous and Synchronous Communication

Asynchronous and synchronous communication was addressed more specifically in 21 segments of 15 studies. These study segments focused on activities such as collaboration, feedback, question and answer sessions, practice, and tutorials. The most commonly mentioned tools in these passages were Google tools and Blackboard tools (Crane, 2017; Machajewski, 2017; Radoli, 2017). General chat and instant messaging were also prominent resources examined and are included as separate themes. A complete list of technology tools and activities used for feedback for formative assessment purposes can be found in Appendices D and E.

Discussion Board. Discussion board use was the subject of five segments of the same number of studies. Formative assessment activities focused on in these sections included peer feedback, reflection, analysis, and knowledge construction (Easterday et al., 2017; Elizondo-Garcia & Gallardo, 2020; Sánchez-Gómez et al., 2017). Strategy and

planning were prominent findings in the successful use of discussion boards for formative assessment practices (Elizondo-Garcia & Gallardo, 2020). One of the passages referred to discussion boards as a place for language learning practice, with peer feedback (Sánchez-Gómez et al., 2017). Participation by students and instructors was another area of data collected on discussion boards in the selected studies (Page et al., 2020).

Chat. Chat as a technology resource used in formative assessment was examined in 13 study segments from six different studies. Chat tasks related to formative assessment discussed in these passages included question and answer, peer feedback, immediate feedback, instructor feedback, and practice for language learning. Both audio and text chat were discussed in the segments. Resources found were WhatsApp, Skype, Facebook Chat, Online Meeting, GroupMe, and general social networking (Bin Dahmash, 2021; Crane, 2017; Radoli, 2017). Another resource discussed in several sections was the chat function of the CMS software in use (Thompson et al., 2017; Vasquez, 2017). Recordings of chat sessions, as well as class sessions were cited as being used for reflection and revision (Bates & Donaghue, 2021).

Email. Data regarding the use of email specifically for formative assessment communication were present in 10 study segments out of three separate studies. Email was listed as being used for question and answer (Hurtado, 2017; McCorkle & Coogle, 2020). Email was also used for scaffolding of student knowledge (Hurtado, 2017). Two studies stated that the documentary nature of email, and the way that the communication can proceed chronologically allowed them to test for understanding, build on current knowledge, and repeat the process until the goal was reached. Email was also found to be used as a tool for feedback delivery in general. Email within a CMS and email functions specific to different assigned groups were described as well (Kumar & Johnson, 2019;

McCorkle & Coogle, 2020).

Wikis. Five of the selected studies provided information about what tools are used for wikis, and in what context wikis might be a good tool. Radoli (2017) described the use of Google Drive, Blackboard Wiki, and Box in implementing wikis as a formative assessment tool. Hegarty and Thompson (2019) looked at the use of Evernote and Google+ as tools in formative assessment activities.

In the above section, findings are reported by theme and research question. All themes come under the umbrella term of feedback. Feedback is examined as asynchronous or synchronous. In terms of Research Question 1, what technological formative assessment resources are being used by the teachers and students, the examination of themes leads to a list of resources, tools, and methods that are used to assist in the formative assessment process. Word frequency was then used to locate data for further analysis. Data examined included written, video, and audio feedback. The software that is used to attain this information for use in formative assessment were identified and listed. On a broad stroke, specific learning management systems and CMSs were identified. Further examination revealed subcomponents of these that facilitate the functions of written feedback, email, discussion boards, collaboration, chats, blogs, peer reviews, and critical reflection. These same methods were applied to the two supporting questions for Research Question 1: Supporting Question 1.1 and Supporting Question 1.2.

Results for Supporting Question 1.1

This section examines the relevant data to identify the similarities in the success or failure of technological tools in accomplishing formative assessment tasks. Themes identified through word frequency queries have been explored to answer Supporting

Question 1.1: What similarities exist in reported findings about assessment resources currently in use? The overarching activity explored in this section is formative assessment feedback. The tools that were utilized to deliver feedback were chat function, discussion boards, and email. Finally, the temporal nature of the feedback, asynchronous or synchronous, was explored.

Chat. The search term chat revealed six segments in four studies that described the chat function being used for formative assessment practices. These sections provided information about frequency of the chat function to provide feedback (Radoli, 2017; Thompson et al., 2017; Vasquez, 2017). Mobile devices, such as smart phones were the technological tool used in activities in two of the identified studies (Hegarty & Thompson, 2019). Skype was the tool used in one segment of one study, related to research question one (Crane, 2017). One study coded at this node reported on the use of the GroupMe collaboration tool (Crane, 2017). The use of the chat function of the Blackboard synchronous classroom was the tool described in two of the included studies at this node (Thompson et al., 2017).

Discussion Boards. The search term discussion boards revealed four segments in three studies that described the use of discussion boards and forums in order to accomplish formative assessment tasks. This section provided information the use of discussion boards to provide peer-to-peer feedback (Elizondo-Garcia & Gallardo, 2020; Hurtado, 2017; Page et al., 2020).

Email. The search term email revealed three segments in three studies that described email being used for formative assessment communication tasks. These sections provided information these sections related the types of communication for which email was a valuable formative assessment tool (McCorkle & Coogle, 2020). One

coded passage related student preferences for the use of email to answer subject matter

questions (Hurtado, 2017). Another coded section discussed the benefit of using email to

answer more complex questions or to provided lengthy answers (Radoli, 2017). Finally,

one section related the use of email in conjunction with discussion boards for a fuller,

more comprehensive formative assessment plan (McCorkle & Coogle, 2020).

 Asynchronous and Synchronous Feedback. This section examines formative

assessment feedback delivered using tools asynchronously and synchronously.

Asynchronous feedback is discussed in six sections of three studies. Synchronous

feedback was discussed in three sections of three studies providing data answering

Supporting Question 1.1. Blackboard tools, phone texts, GroupMe, and Google are the

tools described in these two sections (Chen et al., 2020; Crane, 2017; Radoli, 2017). Data

on asynchronous tools included Blackboard Collaborate, mobile phone text messages,

GroupMe asynchronous chat, Blackboard discussion groups, email, and wikis, and

Google groups (Chen et al., 2020; Radoli, 2017). Synchronous communication tools

discussed in these studies include Google Hangouts, Adobe Connect, Webex, instant

messaging on several platforms, Skype, and GroupMe (Crane, 2017; Radoli, 2017).

 The above section looked at data related to the similarities of technological tools

in successfully assisting in the accomplishment of formative assessment activities. The

main activity appearing in the data involved feedback. The data showed the use of the

chat function, discussion boards, and email being used to deliver and receive formative

assessment feedback. Another important characteristic reported in this section was the

asynchronous or synchronous nature of the feedback being studied.

Results for Supporting Question 1.2

 This section reports the data related to the differences occurring in the successful

use of technological resources in formative assessment tasks. Frequently occurring terms

provide the framework for exploration of Supporting Question 1.2: In what way do

reported findings show differences in assessment resources currently in use? The main

term being reported is formative assessment feedback. Terms relating to the temporal

aspect of the feedback, asynchronous feedback and synchronous feedback, are also

explored in this section. Finally, tools used to perform formative assessment tasks are

examined. The two terms that appeared in the data are chat function and email.

Feedback. The theme feedback provided 224 segments of 64 different studies

that contained information that identified differences in resources currently being used

for formative assessment. The data were classified by which section of Supporting

Question 1.2 that it addressed and by the specific term themes that have been identified.

For Supporting Question 1.2, two segments of three studies answered the research

question in general, providing information about the existence of similarities and

differences in the use of the various technology tools being examined in this study.

A further query on the frequency of terms in the included sections revealed

themes related to two areas, activities, and communication. Various activities were

described numerous times, including work, writing, interaction, practice, and reflection.

Activities were described as group and individual, as well as cognitive. Communication

terms that were prevalent in the segments were question, response, audio communication,

video communication, and communication that was described as positive or constructive.

Differences in success and failure were related to the characteristics of the

feedback in several of the studies. The source of feedback (i.e., peer, instructor, or tutor)

was one area that produced some differences in results. Other factors of feedback that

were examined for success or failure were personal feedback, positive feedback, written

feedback, audio feedback, video feedback, and the use of clickers. The vehicle of feedback delivery showed some differences in success or failure of the process. Email and the Mobile-Assisted Language Learning model were two of the systems studied (Hegarty & Thompson, 2019; Soria et al., 2020). Wikis, discussion boards, blogs, and collaborations were activities that related to this question. Finally, the timing of feedback gave great clues as to the success or failure of the process. Timeliness related to the activity being assessed was one factor studied (Di Gregorio & Beaton, 2019; Hegarty & Thompson, 2019; Martin et al., 2020). Immediate feedback was studied in relation to language learning (Gafni et al., 2017). Where the feedback fell in the learning process was also a topic in this question. For example, does the student have time to address the feedback before the final learning product is due?

Asynchronous and Synchronous. A total of five segments, each from a different study, provided information about similarities and differences in asynchronous and synchronous communication for the purposes of formative assessment. The information provided by the selected studies in this section related to similarities and differences in timing, as well as the multiple tools available to accomplish both asynchronous and synchronous formative assessment tasks (Reeves, Gunter, & Lacey, 2017). For example, Blackboard discussion boards, Google Discussion, and Advanced Content Editor all perform the asynchronous task of discussion boards. One study noted the difference in tone between asynchronous and synchronous online class activity (Tatsanajamsuk & Saengboon, 2021).

Chat. Chat qualities as a formative assessment tool were described in four segments of two studies. The information in these studies identified three main characteristics that demonstrated the similarities and differences in chat activities. The

hardware and software used for chat activity provides for many similarities and differences that are described in the next research question section. The organization and scheduling of chats is also a topic that was identified as providing differing results (Bognar & Krumes, 2017; Thompson et al., 2017). Finally, the functions of the chat programs used create a comparison of chat activities (Thompson et al., 2017).

Email. The use of email as a tool of formative assessment was discussed in two segments of two studies. These passages addressed the ease of use and the timing of emails (Hurtado, 2017; McCorkle & Coogle, 2020). Email used in conjunction with office hours was discovered to work well for question-and-answer processes, as well as tracking corrections and learning changes (Hurtado, 2017; McCorkle & Coogle, 2020).

Themes were identified that provided data to answer Supporting Question 1.2: In what way do reported findings show differences in assessment resources currently in use? Feedback was, again, the umbrella term, with the themes showing themselves in sections describing feedback. The information is divided into two categories, activities and communication. The sections were examined as to successes and failures, as well as the source of the feedback. Characteristics that created successful or unsuccessful outcomes were analyzed, leading to the first subquestion of Supporting Question 1.2 (Subquestion 1.2.1), which noted these successes, failures, and difficulties in the use of the resources:

Results for Research Subquestion 1.2.1

This section describes the data in the relevant segments that describe the success, failure, and difficulties in using the technological tools utilized to perform formative assessment tasks. Terms found through word frequency queries, and the passages surrounding them, were examined to answer Subquestion 1.2.1: Do differences exist in the success, failure, or difficulty of use of resources currently in use? The data are

reported first in the umbrella theme of feedback. Further examination in this section explores the data on asynchronous and synchronous use of the technological resources. Finally, the specific tools of chat function, discussion boards, email, and wikis are described in this section.

Feedback. The segments returned on the feedback query contained 112 passages in 57 studies that related to Subquestion 1.2.1. The passages relayed information on activities and communication. There were 48 segments, found in 34 studies, which answered the question of success, failure, and difficulty of use of technology tools for formative assessment in general terms, and the use of wikis as a tool in formative assessment activity was looked at in four study segments from three studies. The segments described activities that were basic learning activities such as studying or class work. Activities were also described in the cognitive terms of thinking, processing, and reflection. Finally, interactions were described. The terms that appeared most often relating to communication activity were written, positive, personalized, and answers.

Asynchronous and Synchronous. Differences in asynchronous and synchronous communication for formative assessment were explored in 14 study segments out of eight different studies. CMS and conference software were the main topics compared in the study segments. Blackboard, Wimba, and Moodle were topics of several studies (Crane, 2017; Gafni et al., 2017; Hojeij & Hurley, 2017; Hurtado, 2017) . GoToMeeting, Online Meeting, and Skype were among the videoconference software examined (Backs, 2017; Radoli, 2017). Google tools were discussed in the selected passages (Crane, 2017; Hegarty & Thompson, 2019; Machajewski, 2017; Radoli, 2017). The activities that were studied that showed differences in asynchronous and synchronous resources were collaboration, discussions, feedback, question and answer sessions, practice, and

tutorials. Appendix D includes a full list of resources and activities and the studies in which they appear.

Discussion Board. Discussion board issues were examined in 10 coded passages from five different studies. One study explored learner perception of the activities involved in discussion board participation (Page et al., 2020). Other studies examined how differing characteristics of discussion boards affected their use. Three studies compared the use of discussion boards as feedback delivery systems other methods of delivering discussion feedback (Barkand, 2017; Elizondo-Garcia & Gallardo, 2020; Page et al., 2020; Radoli, 2017).

Chat. More specific answers to the research question related to the theme of chat as a formative assessment tool was found in five study segments from four studies. Two studies addressed the use of mobile phones for educational chat sessions (Andújar-Vaca & Cruz-Martínez, 2017; Soria et al., 2020) . Two studies examined differences in the chat function in the CMS in use (Chandran et al., 2021). Two studies compared text-based chat to audio-based chat (Chandran et al., 2021). One study compared asynchronous to synchronous chat as a formative assessment tool (Hrastinski et al., 2018).

Email. Successes and problems related to the use of email for feedback purposes was discussed in five study segments from five studies. The focus of all of the passages were on different qualities in the perceptions and results of using email as a vehicle for feedback and questions. One study examined email as a tool to deliver corrective feedback (McCorkle & Coogle, 2020). One study addressed technical issues with email use (McCorkle & Coogle, 2020). Several of the studies discussed positive and negative characteristics of email use for formative assessment that are addressed in another section of this study.

Wikis. Subquestion 1.2.1 relates to the difficulty or ease with which different technology is used in formative assessment activities. Three studies out of the selected studies addressed this issue. One study found that the students in that study chose online wikis personal knowledge management (Hsiao & Huang, 2019). One study found that online collaboration software created a transparent working situation, which helped group members understand what other students were working on (Hegarty & Thompson, 2019). Hsiao and Huang (2019) noted the importance of instructor guidance in the peer feedback process. Classes without an instructor provided structure for feedback had students that received an insufficient amount of peer feedback (Hsiao & Huang, 2019). Sánchez-Gómez et al. (2017) found different results among self-reporting students in a study of perceptions of wiki e-activities by students in different age groups. Students in younger adult age groups found wikis helpful in knowledge construction, collaboration, autonomous, and collaborative learning. As the age of the student respondent reached 30 or more, a statistical drop in the perception of wikis as helpful in the above categories was recorded (Sánchez-Gómez et al., 2017).

In the previous section, segments of the studies were identified that answer the question, do differences exist in the success, failure, or difficulty of use of resources currently employed to address formative assessment activities? Once again, the umbrella term of feedback assisted in identifying asynchronous and synchronous tools and methods of using technology to accomplish formative assessment tasks. Segments were identified that addressed chat, email, discussion board, and wiki activities. Further examination was made to answer Subquestion 1.2.2, which described these differences, similarities, and difficulties of using technological tools to perform formative assessment tasks.

Results for Research Subquestion 1.2.2

In this section, data were reviewed to further explain the differences in the use of technological resources in accomplishing formative assessment tasks. Frequently occurring themes have been explored further to answer Subquestion 1.2.2: What are the differences in success, failure, or difficulty of use of resources currently in use? Once again, data related to the general term of feedback is described. Next, the asynchronous and synchronous nature of the tools is explored. Finally, the specific tools of the chat function, discussion boards, email, and wikis are examined.

Feedback. In the 85 segments of 34 studies that contain information to answer Subquestion 1.2.2, the most frequent terms relate to activities such as student work, writing, collaboration, discussion, and comments. Processes such as practices, changes, and learning are represented in the sections identified in this area. The types of processes examined are constructive, suggestive, and cognitive (Easterday et al., 2017). The success, failure, or ease of use of technology for formative assessment depends on the purpose, the activity, and the knowledge of the instructor or tutor in the use of that technology. The major themes revealed in these passages revealed that asynchronous and synchronous feedback have value relative to the subject matter and form of the feedback. The other major theme revealed in this section was the long list of characteristics of feedback that can make it successful or not. These characteristics can relate to delivery of the feedback, purpose of the feedback, or timing of the feedback.

Asynchronous and Synchronous. There were 25 segments of 16 studies that discussed the details of the differences in carrying out asynchronous and synchronous communication for formative assessment purposes. Several studies found that

synchronous communication was more effective than asynchronous, with some differences found between text, audio, and video communication (Crane, 2017; Gafni et al., 2017; Martin et al., 2020; Simpson et al., 2019). Text-based, asynchronous communication for formative assessment activities was found to be more beneficial in six of the study segments (Martin et al., 2020; Simpson et al., 2019). Practice and repetition were found to be positive factors in five studies (Crane, 2017; Martin et al., 2020; Robertson et al., 2019; Shang, 2017).

      Discussion Board. Discussion board activities that are meant to formatively assess student learning are the subject of five of the segments of four studies coded at this research question. The data in these studies suggest that specific characteristics, which are discussed in the next chapter of this study, must be present for discussion boards to be successful tools for formative assessment activity (Easterday et al., 2017; Elizondo-Garcia & Gallardo, 2020; Page et al., 2020; Sánchez-Gómez et al., 2017).

      Chat. The use of chat resources was the subject of seven segments of seven studies that relayed information pertaining to the research question. Chat usage affected by the technical ability of the users and instructors was the topic of one study (Soria et al., 2020; Udeshinee et al., 2019). The occurrence of off task behavior causing lower effectiveness of chat as a feedback tool was indicated in one study (Soria et al., 2020). The confusion caused by multiple chat threads was the topic of one study segment (Thompson et al., 2017). Adding functions to the chat environment to enhance effectiveness and ease of use was the topic of two study sections (Chen et al., 2020; Radoli, 2017). The presence of cues in video chat, as well as the absence of such cues in text chat, and the subsequent successes and difficulties were the topics of one study segments (Chandran et al., 2021).

Email. Nine segments from three studies related to the use of email provided answers to the question of the details of the differences in the success, failure, or difficulty of use of technology tools for formative assessment. The success of email, as discussed in two studies, is related to the ability to track the work, and the ability to use it without scheduling issues (Crane, 2017; Hurtado, 2017; McCorkle & Coogle, 2020). The drawbacks of email as a feedback source, namely the lack of contextual information, was indicated in one study (McCorkle & Coogle, 2020).

Wikis, Blogs, E-portfolios. Four articles provided information related to wikis, blogs, and ePortfolios to answer Subquestion 1.2.2 regarding the characteristics of wikis as a tool in formative assessment activities. The terms used to describe wikis as a tool were dynamic and collaborative (Di Gregorio & Beaton, 2019; Hegarty & Thompson, 2019; Mohamadi Zenouzagh, 2019; Tur et al., 2019).

In the above section, selections of the included studies were examined to identify the difficulty or ease with which technological resources are used to perform formative assessment activities, as well as the differences and similarities between tools and methods. The data were examined through the umbrella term feedback, with asynchronous and synchronous activities as a subheading. The tools examined were discussion boards, chat sessions, email, and wikis. This section examined descriptive data of the list of activities that exhibited differences and similarities and successes and failures, which were identified in the last section.

Results for Research Question 2

Identified sections of selected studies were probed for high-level themes that help to discover how these terms can help answer the research question: What formative assessment information do the teachers gain as the authentic assessment activities are

carried out? The information returned by a search of key terms on the discussion and results sections of the selected studies were evaluated at the sentence level to see if data were present that answered any of the research questions covered by Research Question 2 and the more indepth subquestions under Research Question 2.

Data that answered Research Question 2 gave a general list of the assessment information that teachers and students were shown to have gained through the assessment activities carried out in the studies. Instructors receive information regarding student concept construction, content revision, knowledge construction, skill construction, and participation and on task behavior. Students receive feedback in the form of corrective information, critical reflection stimuli, guided instruction, and skills practice stimuli. Findings coded at Supporting Question 2.1 described the target of the assessment activities examined in the studies, and data coded at Supporting Question 2.2 explained the impact on the ongoing learning process of those activities, as shown in the study results.

There were 170 passages that provided information to answer any of the questions included in Research Question 2. These segments were coded according to which section of Research Question 2 was answered by the data. Research Question 2, in general, was addressed in three segments from three different studies. Supporting Question 2.1 was addressed by a total of 55 segments in 41 studies. Supporting Question 2.2 was answered in a total of 112 segments of 52 separate studies. Terms appearing frequently in these passages addressed types of feedback, activities, feedback recipients, and feedback vehicles. The most common terms in these passages that related to types of feedback were responses, comments, discussions, and communication. The most often used descriptive terms for this feedback were supportive, corrective, and constructive.

Activities discussed in these sections included study, work, writing and processes.

Feedback delivery themes most often appearing in these sections were video feedback,

audio feedback, mobile feedback, and digital feedback. In this section, major themes

identifying what type of information were provided by formative assessment activity.

This section introduced the concept of targets of formative assessment activity. This

section also presented the types of information provided in formative assessment

feedback and the recipients of that feedback.

Results for Supporting Question 2.1

In this section, further exploration of frequently occurring terms answer

Supporting Question 2.1: What is the reported target of the assessment resource being

studied?

Feedback. Supporting Question 2.1 was addressed by a total of 55 segments in 41

studies. The question, in general, was answered in 21 segments of 13 studies. Another 34

segments coming from 28 studies answered on more specific themes. The target of the

assessment activity could be information intended for the student or the instructor.

Instructors in the selected studies obtained information relating to student

comprehension, skills and concept acquisition, content or knowledge retention,

participation and on task behavior, as wells as synthesis and analysis student processes

(see Table 2). The targets appearing the most in the selected studies were skills and

concept acquisition, student processes, and comprehension.

Participation and on-task behavior also represented common information sought

by instructors for formative assessment purposes. Students also received formative

assessment information in the studies. Students received information through guided

instruction, for revision or practice, to facilitate reflection, and for knowledge

construction. Students also received formative assessment information that assists in

filling gaps in content knowledge and for skill reinforcement. The most common

information provided to students in the selected studies was for revision or guided

instruction activities.

Table 2

Formative Assessment Targets

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Target of assessment	Author	Type of feedback or feedback tool
Comprehension	Di Gregario (2019)	Written feedback
Comprehension	Canals (2020)	Video feedback
Concept acquisition	Hsiao (2019)	Wikis, blogs, and social networks
Concept acquisition	Ellis et al. (2017)	Synchronous tutoring
Concept acquisition	Lowenthal (2020)	Asynchronous video
Content retention	Klimova (2020)	Mobile Applications
Content retention	Schmitz (2019)	Exams and assignments as feedback
Knowledge acquisition	Ebadi (2021)	Written feedback
Skills acquisition	Di Gregorio (2019)	Wikis, blogs, and social networks
Skills acquisition	Hurtado (2017)	Written feedback
Skills acquisition	Reeves et al. (2017)	Informal feedback

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Asynchronous and Synchronous. The target of asynchronous and synchronous

activities was the subject of 20 coded segments of 12 studies. Among the information that

instructors acquired during these studies related to asynchronous and synchronous

feedback, two studies contained data on content retention checking (Klimova &

Polakova, 2020; Schmitz, 2019). One article addressed skills acquisition assessment

(Crane, 2017). Data about instructors evaluating participation were found in four studies

(Di Gregorio & Beaton, 2019; Hurtado, 2017; Wilton et al., 2019; Zuhrieh & Sara Abd

Al, 2020).

Data about students receiving guided instruction represented the most prevalent

topic in the sections related to asynchronous and synchronous feedback, appearing in one

study (Crane, 2017). Data related to revision and skills practice were each present in three

of the selected studies (Abri, 2021; DeMara et al., 2019; Ebadi & Alizadeh, 2021; Hsiao & Huang, 2019). Corrective information was the topic of two of the selected passages (Canals et al., 2020; DeMara et al., 2019). Critical reflection was the topic of one passage in a study dealing with asynchronous and synchronous feedback (DeMara et al., 2019).

Discussion Board. Discussion board activity assessment targets represented the topic of four segments of two studies. Instructor assessment target information in the studies were measurement of skill acquisition in three of the studies (Easterday et al., 2017). Target information measuring analysis activity was examined in two of the studies (Easterday et al., 2017; Howell et al., 2017). Knowledge and content acquisition represented the target looked at in two of the studies (Easterday et al., 2017; Howell et al., 2017).

Chat. The formative assessment target of chat activities represented the topic of five segments of two articles. Instructors received information to evaluate skills construction in one study (Andújar-Vaca & Cruz-Martínez, 2017). Assessment of knowledge construction and content retention were examined in one study each (Thompson et al., 2017).

Email. Email assessment targets were the subject of one coded section. This section was related to language learning and pointed out that it was helpful in checking for comprehension, content, and skills retention, but only for more advanced students (Hurtado, 2017).

Wikis, Blogs, and E-portfolios. Four studies provided data to answer the question: What impact do wikis, blogs, and e-portfolios have on the ongoing learning process? Wikis were found to be very helpful in guided instruction for the purpose of feedback, and to inform the instructor provided material choices in lessons going forward

(Di Gregorio & Beaton, 2019; Hsiao & Huang, 2019; Mohamadi Zenouzagh, 2019; Tur et al., 2019).

The above section examined the reported target of the assessment resources being studied. Again, feedback was the umbrella term, followed by synchronous and asynchronous, with the nodes of discussion board, chat, email, and wikis being utilized to categorize the activities and tools identified. Sections were identified by a word search, and cognitive activities and learning goals were examined and listed as targets of the formative activity being studied. This information was used to examine the impact of the activity on the learning process being studied.

Results for Supporting Question 2.2

In this section, themes were further explored to determine the impact of the target of assessment on the learning process, answering Supporting Question 2.2. The formative assessment targets examined in this section were comprehension, concept acquisition, content retention, knowledge acquisition, and skills acquisition. The temporal aspect of asynchronous and synchronous formative assessment activity is looked at in this section. Finally, the gathering of the target formative assessment information utilizing the tools of chat function, discussion board, email, and wikis is explored.

Feedback. Within the passages coded for the term feedback, Supporting Question 2.2 was answered in a total of 112 segments of 52 separate studies. General information describing the impact on the target of the assessment activity was found in 89 segments of 41 articles. Information regarding specific identified themes was found in 23 segments of 11 articles. Data that were reviewed indicated if the formative assessment target information created an action and if that action had a positive, negative, or neutral effect on the learning process.

A further examination of the specific segments of the studies found that terms that appeared frequently fell into two categories: feedback and activities. Types of feedback that appeared in this section were described as positive, constructive, and critical. The terms response and communication were used frequently, as were the terms instructor feedback and peer feedback (see Tables 3 and 4). Feedback vehicles (i.e., video, audio, and digital) were also themes that appeared in these studies. Activity themes in these sections were work, writing, process, thinking, and experience.

Table 3

Formative Assessment Information Received by Instructors

Learning characteristic measured	Author	Formative assessment activity type
Concept construction	Hsiao & Huang (2019)	Wiki
Content revision	McCorkle (2020)	Chat
Knowledge construction	Hsiao & Huang (2019)	Asynchronous
Knowledge construction	Menekse (2020)	Asynchronous
Participation and on task	Hegarty & Thompson	Wikis
Skill construction	Schmitz (2019)	Asynchronous
Skill construction	Kusairi (2020)	Asynchronous
Skill construction	Hurtado (2017)	Email
Skill construction	Callaghan & Reich (2020)	Synchronous
Skill construction	Hegarty & Thompson (2019)	Wikis

Asynchronous and Synchronous. Data about the impact of synchronous and asynchronous activities were found in 12 segments in ten different studies. The delivery system of the feedback had an impact on the outcome on formative assessment corrective actions, and the specific results are discussed in the next section. The other factor that significantly affected the occurrence and positive or negative impact of actions taken on formative assessment information involved the synchronous or asynchronous nature of the feedback based on the assessment.

Discussion Board. Discussion board activity impact information was present in

six segments of three studies. In all of the studies, discussion board formative assessment created corrective activity in the target areas that had a positive result on learning (see Table 5).

Table 4

Formative Assessment Information Received by Students

Type of feedback	Author	Activity type
Corrective information	Topacio (2018)	Asynchronous
Corrective information	Andújar & Cruz (2017)	Chat
Corrective information	Hurtado (2017)	Email
Corrective information	Hegarty & Thompson (2019)	Wikis
Critical reflection	Menekse (2020)	Asynchronous
Critical reflection	Canals (2020)	Chat
Critical reflection	Hegarty & Thompson (2019)	Chat
Critical reflection	Page (2020)	Discussion Board
Critical reflection	Hegarty & Thompson (2019)	Wikis
Guided instruction	Klimova & Polakova (2020)	Synchronous
Guided instruction	Hegarty & Thompson (2019)	Wikis
Revision information	Hsiao & Huang (2019)	Asynchronous
Revision information	Hegarty & Thompson (2019)	Wikis
Skills practice	Ko (2019)	Asynchronous
Skills practice	Kusairi (2020)	Asynchronous
Skills practice	Li & Li (2018)	Asynchronous
Skills practice	Andújar & Cruz (2017)	Chat
Skills practice	Callaghan & Reich (2020)	Chat

Table 5

Formative Assessment Information Generated by Formative Assessment Activities Utilizing Discussion Boards

Learning characteristic measured	Author	Recipient of formative assessment Information
Concept construction	Easterday et al. (2017)	Instructor
Concept construction	Howell et al. (2017)	Instructor
Content revision	Howell et al. (2017)	Instructor
Guided instruction	Easterday et al. (2017)	Student
Knowledge construction	Easterday et al. (2017)	Instructor
Knowledge construction	Howell et al. (2017)	Instructor
Skill practice	Andújar & Cruz (2017)	Student
Skill practice	Easterday et al. (2017)	Student
Skill construction	Andújar & Cruz (2017)	Instructor
Skill construction	Easterday et al. (2017)	Instructor

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Chat. Details about the impact of activities using the chat function was found in three segments of two articles. In all of the study segments selected, formative assessment using the chat function created corrective action that had a positive result on the learning process.

Email. Finally, the impact of email assessment activities on the target of the action was detailed in three sections of one study. This study found that email was useful in both directions. Email as a method of students expressing need of formative assessment from the instructor created positive results. Email was then used to relate corrective information that students used for positive formative assessment activity.

The above section described the findings on the impact the formative assessment activities being studied had on the target of those activities. Data were isolated by the term feedback first, followed by dividing it into asynchronous and synchronous. The data were further reported by the nodes of discussion board, chat, email, and wiki. The formative assessment targets examined were comprehension, concept acquisition, and content retention. The next section identifies the action instigated by the formative assessment activities studied in the previous sections.

Results for Research Question 3

In this section, frequently occurring terms were further examined to answer Research Question 3: How are teachers using the information gathered using formative assessment technology during authentic assessment activities to improve student learning experiences? The umbrella term of feedback was explored to reveal data that were further examined in the sections on the supporting questions of Research Question 3. Under the umbrella term of feedback, the terms peer feedback, instructor feedback, digital feedback,

quality feedback, timely feedback, and personal feedback are delineated.

Feedback and activities that were described in 240 segments of the passages in the feedback query provide information to answer Research Question 3 and the supporting questions included in Research Question 3. One segment related to Research Question 3 in general terms. A total of 76 segments of 39 studies provided information that would answer Supporting Question 3.1, addressing the new teaching and learning activities that result from the formative assessment activities occurring. A description of changes to ongoing learning activities, which was addressed in Supporting Question 3.2, was addressed in 82 segments of 46 studies, and 81 segments of 57 studies explored technology used in formative assessment activities in which the actual formative assessment feedback was a part of the learning activity, addressing Supporting Question 3.3. The themes that would fit under the feedback umbrella included responses, information, peer feedback, instructor feedback, digital feedback, and quality feedback. The activities identified through word frequency in these sections included writing, learning, essays, reflection, assessment, process, participation, and revision. The above section explained the data found that revealed terms related to how teachers use the formative assessment information they gather. This section delineated the terms peer feedback, instructor feedback, digital feedback, quality feedback, timely feedback, and personal feedback, organized under the umbrella term of feedback as activities identified in the included studies.

Results for Supporting Question 3.1

This section looks at the data that answered Supporting Question 3.1: Does the assessment target information lead to new teaching and learning activities? This was answered in segments of the selected studies as identified through word frequency

queries. This section explores learning activities that are added to planned learning in response to formative assessment information. This section examines the data in terms of the temporal aspects of asynchronous and synchronous communication, as well as the use of the chat function, discussion boards, email, and wikis to exchange formative assessment feedback and adjust learning plans to correct issues revealed by formative assessment activities. In order to meet the criteria of new teaching and learning activities, the activity must be one that was not in the original plan, or an activity that is different from existing activities being performed specifically to address a need found in the formative assessment process.

Asynchronous and Synchronous. Synchronous and asynchronous communication of those changes in activities was discussed in 41 segments from 20 different studies. Of these sections, 35 answered the research question in the affirmative, four answered negatively, and one gave a mixed yes and no answer.

Discussion Board. Discussion board activities that included changes in ongoing activities due to formative assessment information was looked at in 12 sections of eight different studies. Of the sections examined, nine answered in the affirmative, two answered negatively, and one described a negative answer, clarifying that if certain characteristics were present, the answer to the question would be affirmative.

Wikis. Data on the use of wikis in this manner were described in one study segment. That segment indicated affirmatively that the activity did lead to new teaching and learning activity.

Chat. The use of the chat function to affect changes in ongoing activities was described in ten segments of eight studies. In each of those sections, new teaching and learning activity was indicated.

Email. The use of email in conjunction with changes in ongoing activities was described in four passages of three studies. New teaching and learning activities were found in each of those segments.

The above section lists the results of a yes or no question: Does the assessment target information lead to new teaching and learning activities? This question also leads into the nature of what new teaching and learning activities are. The data were organized under the umbrella term of feedback, with sections discussing asynchronous and synchronous tools and methods. Data were also coded at the nodes of discussion board, CMS, chat, and email. The results here were coded as to a simple yes, new activities were instigated or no, new activities were not instigated. This was differentiated from the next section, which noted assessment activities that changed existing activities.

Results for Supporting Question 3.2

This section includes frequently occurring themes that were examined at the sentence level to answer the question: Does the assessment target information lead to changes in ongoing activities? A change in ongoing activities was further defined as any altering of ongoing activities, but not a new or different activity that is added. The data were organized under the umbrella term of feedback. Tools to deliver feedback and changes to the learning plan in response for formative assessment information discussed in this section included chat function, CMS, discussion board, email, and wikis. The data are also discussed in terms of asynchronous and synchronous activities.

Feedback. In 82 segments of the studies that were identified in the feedback query, answers to Supporting Question 3.2 (Does the assessment target information lead to changes in ongoing learning activities?) were apparent. General information relating to those changes was found in 52 segments of 24 articles. Themes frequently appearing in

these segments were the activities writing, learning, revisions, reflection, work, and practice. Several feedback types were also common themes, including digital feedback, online feedback, peer feedback, individual feedback, effective feedback, constructive feedback, quality feedback, and answers.

Asynchronous and Synchronous. Synchronous and asynchronous communication of those changes in activities was discussed in 43 segments from 23 different studies. Of these sections, 35 answered the research question in the affirmative, four answered negatively, and one section showed a mixed yes and no answer.

Discussion Board. Discussion board activities that included changes in ongoing activities due to formative assessment information was looked at in twelve sections of eight different studies. Of the sections examined, nine answered in the affirmative, two answered negatively, and one described a negative answer, clarifying that if certain characteristics were present, the answer to the question would be affirmative.

Wikis. Data on the use of wikis in this manner were described in one study segment. That segment indicated affirmatively that the activity did lead to new teaching and learning activity.

Chat. The use of the chat function to affect changes in ongoing activities was described in 18 segments of 10 studies. In each of those sections, new teaching and learning activities were indicated.

CMS. CMS usage for formative assessment activity was present in one section of one study.

Email. The use of email in conjunction with changes in ongoing activities was described in 10 passages of five studies. New teaching and learning activities were found in each of those segments.

The above section reported the findings of the question: Does the assessment target information lead to a change in ongoing activities? The umbrella term of feedback was used to isolate sections of articles that yielded targeted sections that addressed asynchronous and synchronous feedback, and the tools discussion boards, chat, CMS, email, and wikis. Each of these sections were examined and the answers of yes, no, or a mixed answer to the research question were assigned to the segment. The last section of this study is further illuminated by Supporting Question 3.3, which examined if the target and/or result of the formative assessment activity was an integrated part of the lesson.

Results for Supporting Question 3.3

This section examines themes that occurred often in these sections and were further examined to inform the answer to Supporting Question 3.3: Is integration of the assessment target information part of the goal of the learning activity? As in other sections, the data were organized under the umbrella term of feedback. Feedback was explored as to the asynchronous or synchronous nature of the interactions. Finally, this section looks at sections of data related to chat function, discussion board, and email as tools in the formative assessment feedback process that are often included in planned learning.

Feedback. The 81 passages identified as containing information that addressed Supporting Question 3.3 were further coded into the themes identified in this study; 35 passages from 25 studies answered Supporting Question 3.3 in general terms. The results were in two categories: themes related to feedback and themes related to activities. The types of feedback themes that appeared most often were individual and peer feedback, self-feedback, information, responses, comments, posts, community, and online feedback. The themes related to activities were work, tasks, essays, blogs, review,

scaffolding, interaction, and improvement.

Asynchronous and Synchronous. Asynchronous and synchronous integration of formative assessment changes was discussed in 29 segments of 23 studies.

Discussion Board. Data regarding the use of the discussion board function with an integrated formative assessment and corrective action characteristic were examined in seven segments of six studies.

Chat. The use of the chat function to perform integrated formative assessment adjustments was described in eight passages of three different studies.

Email. The use of email to communicate this integrated information was the topic of four segments in three studies.

The above section described the results of an examination of actions instigated by formative assessment activity, and situations in which those instances were integrated in the lessons from the planning stage. Results were reported for asynchronous and synchronous activities, and specifically chat, CMS, discussion boards, email, and wikis.

Chapter 5: Discussion

Introduction

  This chapter includes a discussion of the findings of the content analysis of the group of studies that have been identified through a taxonomic analysis as relating to the specific themes that are likely to present answers to the research questions. A short review of the study and analysis of the findings according to each research question and the themes and trends discovered through that analysis. This section examines and interprets the results of the content analysis of the included studies, organized by research question, theme, and tools of technology. The following sections examine the results related to each research question and its subquestions to identify the technological resources that instructors and students use to perform formative assessment tasks and implement formative assessment solutions. The sections are organized around the tools and resources used to accomplish formative assessment activities.

Overview of the Study

  This section includes a description of this study at a high level. Main themes are explained, and major results are reported. The process used to complete this study is described. Sources of data used in this study are enumerated, and the demographics of the participants in the source studies are explored. Formative assessment is used by instructors, students, tutors, coaches, and others to determine student progress in both what and how they learn. Data are returned to the student and instructor that allow for changes in the learning process that will address what the student needs to achieve the learning goal. The information might be diagnostic or it may be feedback meant for the student to use for critical reflection and self-adjustment of learning (Hendriana et al., 2018).

The data used in this study were analyzed to discover technological methods and tools that instructors and students are using to achieve formative assessment goals. The data were further analyzed to determine the success, failure, and difficulties in using these tools and methods. The target of the assessment process became apparent in many of the sections studied, which led to information about the impact of the targeted formative assessment activity on the ongoing learning process. The data were examined to discover if the assessment target information led to new teaching and learning activities, changes in ongoing learning activities, or if the integration of the assessment target was a planned part of the lesson to begin with.

The data were harvested from 59 academic journal articles, eight dissertations or theses, and four reports in other forms. These studies examined activities from a broad range of educational levels (see Table 6). The grade levels ranged from kindergarten through 12th grade, to just one or two age groups, to the broad group labeled adults and traditional and nontraditional college and university students at all levels. These numbers cover students and instructors. The instructor group included coaches, tutors, and student teachers if they were in the instructor position for the study. The majority of the data came from studies of university students in various capacities, including undergraduate and graduate students.

The studies utilized for this content analysis were classified by country, region, and with the term *international*. Of the studies performed in North America, 21 were in the United States. The studies in the United States were broadly defined by country in 14 instances. When region was used to describe the studies in the United States, one was identified as in the Southern United States, three were described as in the Midwest states, two were conducted in the Southwest, and one location was described as a military base

in the United States. Some of the studies named specific states in which they were conducted (see Table 7). Several studies utilized data from participants in more than one state.

Table 6

Education Levels Observed in Data

_____

Grade level	No. studies covering specified grade level
Kindergarten to grade 12	2
Kindergarten	1
5- and 6-year-olds	1
Elementary	3
11- and 12-year-olds	1
Sixth grade	2
Middle school	2
Eighth grade	1
High school	2
Secondary education	1
Teachers	2
Adult	16
Informal	1
Higher education	8
University	74
Graduate	12

_____

Table 7

Location of Participants of Selected Studies in Specified States

_____

State	No. studies in specific states
Arizona	1
California	2
Florida	1
Oklahoma	1
Pennsylvania	1
Virginia	1

_____

Studies conducted with participants in Europe included one each in Belarus, Croatia, Czech Republic, Denmark, Ireland, Portugal, and Slovenia; two studies in Sweden, three studies in the Netherlands and in Spain; and four studies in the United

Kingdom and six studies in Turkey. Australia provided participants for 11 of the studies included in this analysis, including studies that gathered data from participants in multiple countries. Brazil was the only South American country with participants in an included study. Studies in Asia included four studies with participants from Taiwan, three with participants from Saudi Arabia, as well as two studies each with participants from China, Hong Kong, Israel, and Japan.

The countries of Cyprus, Croatia, Czech Republic, Dubai, India, Indonesia, Ireland, Israel, Malaysia, Mexico, New Zealand, Oman, Philippines, Sri Lanka, Sweden, Taiwan, Thailand, and the United Arab Emirates provided participants for one study each. Hong Kong, Iran, and Korea each contributed two included studies. Australia contributed three studies. Studies conducted in Turkey and the United Kingdom contributed data from five studies each. Finally, six studies conducted in Spain contributed data to this study. Some of the data used in this analysis were gathered from studies that had participants in different countries, including one study that contained data from the United States and Australia. This analysis included data from participants in a wide range of locations, both in the United States and around the world.

The sample sizes in the selected studies varied widely (see Table 8). Sample sizes ranged from two participants to 7,000 participants. Studies that did not specify the number of participants were still included in this content analysis because weight was not given to study size, it is only mentioned as a demographic variable to show the wide variety of sources of information available to answer the research questions. The variety of sample sizes in included here to demonstrate the variety of studies included in this analysis.

Table 8

Number of Studies by Sample Size

_____

Sample size	No. studies in that range

_____

One to 10 participants	10
11 to 100 participants	37
101 to 500 participants	14
501 to 1,000 participants	1
Over 1,000 participants	3
Sample size unknown	32

_____

The QCA approach was used in this study to interpret data from rich and varied

sources. A coding frame was developed using taxonomic analysis to identify repeating

terms and themes that referred to data that would answer the research questions. The

researcher examined data sources selected by theme, population, timeliness, and study

type. These sources were then queried to segregate the findings and discussion sections.

When querying to find answers to questions about formative assessment, the theme of

feedback was overwhelmingly prevalent. For this reason, feedback and synonyms of

feedback identified itself as the main theme to query the discussion and finding sections.

Within the feedback query, two temporal themes emerged: asynchronous feedback and

synchronous feedback. The topical themes of tools and digital feedback created another

subset of data. The tools identified as prevalent in these sections were CMS software,

mobile learning devices, video conferencing software, and social networking websites.

The digital feedback section included the results of searches for synchronous and

asynchronous feedback. Synchronous feedback queries returned data about online

classes, chat, virtual office hours, and meetings. Asynchronous feedback included wikis,

blogs, discussion boards, and email. The demographic themes help to describe who uses

the information gathered in formative assessment activities. It is described directionally.

Information goes from student to instructor, from instructor to student, and from peer to peer, mainly. In some situations, there may be a coach or a tutor, which will be included in the instructor role. The data included in this study were limited to primary research results reported in articles, studies, and dissertations.

Discussion of the results of this study starts with a list of the tools and methods that the data have indicated are currently used in distance education, blended distance, and face-to-face education, as well as face-to-face classrooms. The success, failure, difficulties encountered, and differences in these factors are discussed. Next, the type of formative assessment information instructors, students, and tutors receive from the use of these tools and methods is discussed. Finally, the activities that are triggered by these tools and methods are described.

This study looked at formative assessment activities performed using technology by various types of instructors and students. Formative assessment activities provide information to instructors and students to change or create new activities in order to address deficiencies in the learning process and achieve learning goals. The data examined provided information about what activities and tools are being utilized, what the learning target of those activities are, and the results of those activities as described by success, failure, and difficulty, as well as what activity is instigated in terms of changes in current activity and introduction of new activities. This study involved research covering all ages and grades, as well as all continents. Studies examined cover a variety of formats of delivery, including fully online, face to face using technology, fully online, and other delivery combinations (see Table 9). QCA was used to interpret findings, and a discussion of those findings follows. The data was classified as coming from a study of online behavior if the actions studied were performed completely online,

even if that action was just a part of a class.

Table 9

Delivery Format of Formative Assessment in Selected Studies

_____

Format of delivery or technology used	No. studies using format of technology

_____

Blended	9
Face to face using technology	11
Hybrid	1
Online	40
Unclassified	4

_____

Interpretation of Results

The findings of this study are interpreted as answers to the following three research questions:

1. What technological formative assessment resources are being used by the teachers? The first research question had two supporting questions: What similarities exist in reported findings about assessment resources currently in use? In what ways do reported findings show differences in assessment resources currently in use? The second supporting question had two subquestions: Do differences exist in the success, failure, or difficulty of use of resources currently in use? What are those differences?

2. What formative assessment information do the teachers gain as the authentic assessment activity is carried out? The second research question had two supporting questions: What is the reported target of the assessment resource being studied? What is the impact of the target on the ongoing learning process?

3. How are the teachers using the technology formative assessment information gathered during authentic assessment activities to improve student-learning experiences? The third research question had three supporting questions: Does the assessment target

information lead to new teaching and learning activities? Does the assessment target information lead to changes in ongoing activities? Is integration of the assessment target information part of the goal of the learning activity?

Research Question 1

This section discusses the results revealed by the data that answer Research Question 1 and its subquestions. The results are organized into themes revealed with feedback at the highest level. Within the theme of feedback, this section describes the results of the study in relation to the tools that are used to accomplish these formative assessment tasks, including chat, devices, discussion board, email, platforms, and wikis. Data are also described by the temporal terms of asynchronous and synchronous delivery of feedback.

To identify technological resources used by teachers and students to perform and benefit from formative assessment activities, terms related to the themes discovered through taxonomic analysis of the data available related to the tools and methods in use were searched in the identified study segments. The data returned were then placed in the appropriate section of the Research Question 1 node. The data were divided into tools and digital feedback methods. The tools identified as being in use by instructors and students were conference software and websites, CMS, audio, video, and presentation software and sites, social networking sites, mobile devices, email, instant messaging, interactive tools and tutorial sessions. The use of MS Word was prevalent through many of the studies, often using the editing and track changes functions of the program (Ellis et al., 2017; Hurtado, 2017; Kumar & Johnson, 2019).

Conference Software and Sites. A query of the data returned 21 sections of studies that provided information about conference software and sites. Google sites and

tools were in 10 of those sections, and information about the use of Google was included in seven of the studies examined. Various Google tools were used as tools to gather formative assessment diagnostic information and return feedback or change learning activity. Google Discussion Forums, Google Docs, Google Drive, Google Groups, Google Hangouts, Google Tools, and Google Translate were the tools discussed in the included studies. Different Google tools were commonly used to support other technology being used for formative assessment purposes (Hegarty & Thompson, 2019; Izmirli & Izmirli, 2019). Google Docs was described as a preferred tool in two studies for use in collaboration, peer review, and instructor correction (Radoli, 2017). Students already familiar with Google tools were more apt to find it the most useful application in gathering photographs for their ePortfolios (Hegarty & Thompson, 2019).

The other conference software and sites that were in use in the studies examined were Adobe Connect, GoToMeeting, GroupMe, Online Meeting, OWL Sessions, WebEx, and Skype. Skype was the second most prevalent tool and was mentioned in four studies. Bin Dahmash (2021) found that Skype was used more often than Blackboard in language learning that occurred online examined in a 2021 study, as well as in a 2019 study (Kumar & Johnson, 2019). Online meetings, in general were described as successful because of ease of use, chat functions, and work and document sharing, though the majority of students in the study preferred face-to-face collaboration (Chen et al., 2020).

CMS and CMS Components. This section addresses the results revealed in the data in the included studies that describe the various platforms used to accomplish formative assessment tasks. It also discusses the component parts of those platforms. Finally, this section looks at the temporal aspect of formative assessment activity being

accomplished with the help of the platforms, looking at asynchronous and synchronous activities.

The data revealed 15 different classroom software management sites and programs that contained 15 components in use for formative assessment activities. Blackboard was the most common CMS appearing in nine studied sections of six of the studies. The generic term CMS was used without identifying the platform in two of the sections studied. Elluminate was examined in two of the studies, but is included with Blackboard Collaborate, as it has been acquired and renamed. The other platforms found in use in the selected studies were Cornerstone, Duolingo, LOOP, Schoology, GradeSwift, E-Leap, MindTap, Moodle, peerScholar, and Wimba (Backs, 2017; Cohen & Williams, 2019; Crane, 2017; Gafni et al., 2017; Hojeij & Hurley, 2017; Hurtado, 2017; Topacio, 2018).

General CMS components were present in 33 sections. The chat function and the discussion board tool were, by far, the most prevalent in use in the studies. The chat function, both text and audio, appeared nine times in the analyzed sections (Crane, 2017; Vasquez, 2017). Discussion boards were present in eight sections analyzed (Jenkins et al., 2017). The other 12 functions and tools appeared one or two times each. Tools were either used synchronously, with participants receiving information in real time, or asynchronously, with communication taking place at different times. Often, synchronous communication was recorded, so that it could be accessed asynchronously (Topacio, 2018).

Live distance classroom sessions and real-time communication used virtual classrooms, virtual labs, and virtual group areas that included document sharing, the chat function, the raise hand function, automated feedback, and other interactive tools such as

emoticons (Izmirli & Izmirli, 2019). Virtual Office Hours can be used for synchronous feedback one on one with students at a distance (Lowenthal et al., 2017). Asynchronous uses of CMS components include discussion boards, progress tracking, screencasts, time on task trackers, and self-assessments (Topacio, 2018).

Blackboard Learn components, which were examined in nine sections of six different articles, were studied separately. The live classroom functions are contained in the Blackboard Collaborate component of the platform. Evidence was found of successful use of Blackboard Collaborate as an online tool for formative assessment purposes due to the convenience it provided adult students who worked full time. In addition, students who were proficient in the use of technology had the greatest success (Chen et al., 2020). Within the Collaborate classroom, the functions of audio and text chat, as well as document sharing, and the raise hand function are used for formative assessment activities (Crane, 2017; Olesova & Melville, 2017; Vasquez, 2017; Yarahmadzehi & Goodarzi, 2020).

The Blackboard discussion board, as well as discussion boards in general, were also discussed in several of the studied sections as a tool for formative assessment activity. In Radoli's (2017) study of the perceptions of graduate students, Blackboard discussion board was used often for feedback from peers and instructors, with only email and Google drive being used more often. International management students used Blackboard for practice in writing English, and for receiving feedback and correction (Khanal, 2021). Similar to discussion board, Class Notes in E-Leap was found to be the feature that students said helped them the most in language learning. Students described the lack of pressure of an asynchronous note created conditions that allowed them to think about their vocabulary and form accurate responses in the language being learned,

making learning the new content and skills more effective (Topacio, 2018).

Blackboard Wiki was examined in one section studied, and Radoli (2017) found it the least used collaboration tool when compared to email, Google Drive, Blackboard Discussion Board, and Blackboard Drop Box. As each student used more than one of the tools above, Blackboard Wiki was still used by 50 of 91 students. Difficulties in using the Blackboard CMS were found in two of the studies included in this analysis. One study revealed that training was needed before students could efficiently provide feedback in Blackboard (Bin Dahmash, 2021).

Bin Dahmash (2021) discovered that the students in that study were more comfortable providing feedback and collaborating in Google than on the Blackboard CMS. Just as in the use of Blackboard components, training is needed for students to choose and use the most effective Web 2.0 applications to complete ePortfolios and other collaborative projects. One of the major factors in student satisfaction with Web 2.0 applications is the ease of use of the tool on a smartphone (Hegarty & Thompson, 2019). Students also found success with program specific collaborative software, especially if it included synchronous document sharing as a collaboration tool (Mwandosya & Mbise, 2019). Li and Li (2018) reported that the Turnitin application was a valuable tool in the peer review process.

Duolingo, an educational language application, which is free, was used in a study of English language learners in Israel. Successful features of the program included the immediate feedback, corrections, and self-assessment. A possible drawback, lack of human feedback, was found not to be a detraction from the benefit of the program (Gafni et al., 2017). Hojeij and Hurley (2017) reported that students in their study preferred the CMS Edmodo because it afforded them the ability to collaborate and to give and receive

feedback. Another study revealed the same result, as students used a product called NaveCafe to practice sentences, upload material, and view and respond to each other's submissions in order to master new vocabulary (Ko, 2019).

 Chat. This section looks at the use of the chat function to accomplish formative assessment tasks. It examines the methods of accomplishing chat activity, and the success and failure of chat activity. It also discusses the functions available within chat functions in CMS and on other platforms. Chat was found in studies in which it was used as a function of a CMS and separately, as a function using separate applications and websites. The success of those tools is described separately.

 This section addresses the various methods of using chat, and the success, failure, and difficulty of those methods and activities. Chat can be either synchronous or asynchronous. Asynchronous use of chat usually involves the review of a class session recording. The scrolling function of chat was found to be helpful in three different studies, in both the asynchronous and synchronous use of the activity (Bognar & Krumes, 2017; Hrastinski et al., 2018). The ability of multiple students to take part in a chat session was found to be a successful quality by Thompson et al. (2017) reported that technology-mediated chats in that study lasted twice as long as face-to-face discussion sessions. However, students in one study declared a preference for face-to-face discussions (Abri, 2021).

 The list of difficulties and failures of chat characteristics is longer than those found to be helpful. Soria et al. (2020) cited differing needs for differing educational levels. Bognar and Krumes (2017) discovered that emoticons were helpful with this problem. Suleiman also found, in that study, that the synchronous chats included more common language and humor and less technical language. Small chat typing boxes and

difficulty in scheduling synchronous chat sessions were two more difficulties reported (Hrastinski et al., 2018). Text chat was insufficient in that it did not afford oral practice. Audio chat was preferable, but technical difficulties made it difficult to accomplish. Text chat as an asynchronous tool, similar to discussion board activities, allows student to discuss other student work in a transformative manner (Hegarty & Thompson, 2019).

      Discussion Board. This section discusses the use of discussion boards for feedback and reflection formative assessment activities. The information is organized by the direction of feedback: instructor to student and peer to peer. The success, failure, and difficulties of the use of discussion boards for formative assessment activities is also discussed. Discussion boards were prominent as methods of feedback and reflection, two important parts of formative assessment activity (Elizondo-Garcia & Gallardo, 2020). Information returned in these studies showed that instructor input and strategy was important for discussion boards to be used successfully (Page et al., 2020). Difficulty could arise with too much instructor participation leading to students missing opportunities for critical reflection (Elizondo-Garcia & Gallardo, 2020)

      Feedback on discussion board postings, both instructor and peer, led to higher comprehension and concept application in three studies, with constructive feedback found to be the most helpful (Easterday et al., 2017; Sánchez-Gómez et al., 2017). Participation is a key factor in discussion board activities and changes in learning (Barkand, 2017). Several factors were found to influence participation. Specific subjects and questions created a greater participation rate, which was found to be directly related to test scores in one study (Barkand, 2017). Page et al. (2020) discovered that students made gains in comprehension and concept acquisition through both original postings and responses to other students posts on discussion boards. Difficulties were also identified in

the area of participation. Elizondo-Garcia and Gallardo (2020) observed that posts

sometimes lacked depth or were not germane to the topic. Another difficulty in the use of

discussion boards found was that students did not always participate in a uniform, regular

pattern (Elizondo-Garcia & Gallardo, 2020).

   Audio and Video Presentation Tools, Sites, and Software. This section

discusses the use of audio and video presentation tools, sites, and software to accomplish

formative assessment tasks. The information is arranged by the type of tools, sites, and

software used and tasks performed. The efficacy of the use of these tools is also described

in this section. Data were present that showed that audio and video presentation sites and

software were being used to accomplish formative assessment activities in the study

sections analyzed. Video editing software and dynamic advanced content editors are both

used in both the gathering and dispersing of formative assessment information (Henry et

al., 2020). Synchronous feedback from both students and instructors can be effectively

delivered through audio and video media (Izmirli & Izmirli, 2019). Tools used in audio

and video formative assessment include screencasts and visual basic quizzes. Sites used

for formative assessment information gathering and feedback found in the included

studies were Powtoon, Ginger, YouTube, Adobe Connect, and Screencastify (Gündüz &

Akkoyunlu, 2019; Henry et al., 2020; Hojeij & Hurley, 2017; Izmirli & Izmirli, 2019;

Layali, 2017; Radoli, 2017).

   Social Networking Sites. This section examines the use of social networking

sites in formative assessment activities. The types of social networking, as well as

specific social networking sites, are listed. The success, failure, and difficulties of the

sites are also discussed. Social networking sites were discussed as communication tools

for formative assessment activities. Blog was the most commonly occurring theme in the

social networking category. Specific sites mentioned were Blogger, Evernote, Facebook, and Wikispaces (Hegarty & Thompson, 2019; Layali, 2017; Radoli, 2017).

Facebook was also strongly preferred by students in a study related to exchanging visual material to receive feedback to assist in compiling an ePortfolio (Hegarty & Thompson, 2019). Students did find distractions while using Facebook (Hegarty & Thompson, 2019). The ability to log in to other programs on their smartphones was a drawback for some students (Ko, 2019). The website Blogger was successfully used to provide feedback and collaboration in a study of peer assessment (Layali, 2017). Students found Evernote to be easy to use for image manipulation and communication because the application is on their smartphone making access to images convenient (Hegarty & Thompson, 2019).

Mobile Devices. This section discusses the use of mobile devices to accomplish formative assessment activity. The specific mobile devices discussed in the included studies are listed in this section. The success, failure, and difficulty of use of the various mobile devices discovered in the included studies are described in this section. Mobile devices were commonly mentioned as tools in technology assisted formative assessment activities. Mobile phones, smart phones, and iPods were all used in studied activities. The most commonly mentioned mobile devices in the formative assessment activities studied were the iPad and mobile phones (Andújar-Vaca & Cruz-Martínez, 2017; Giang, 2017; Hegarty & Thompson, 2019; Reeves et al., 2017; Yilmaz, 2017). In general, students found mobile devices an effective means of exchanging formative assessment information. Specifically mentioned as qualities of feedback received via a mobile device were timeliness, the quality of the feedback, and the accessibility of the feedback wherever the student may be (Klimova & Polakova, 2020; Ko, 2019).

The iPad was found to be successful in a specific program named Starfall (Reeves et al., 2017). The iPad was also successfully used for audio feedback. Difficulties with the iPad included lack of connectivity and difficulty conveying complex information (Dalby & Swan, 2019). Successful characteristics of mobile phone use in formative assessment were that they were easy to use and could deliver timely feedback (Andújar-Vaca & Cruz-Martínez, 2017). Digital voting systems, otherwise known as clickers, were found to be successful at assessing knowledge among large groups of students and changing teaching strategy accordingly (Asiksoy & Sorakin, 2018). However, Yilmaz (2017) discovered that mobile phones could be used in place of clickers with little cost to the institution. Classroom response systems are applications used on smartphones that have replaced clickers in many classrooms (Onodipe & Ayadi, 2020). Tryout and Webvoting are applications that can be used as digital response systems on a phone or laptop for formative assessment purposes. Instructors can use these applications to check student learning and adjust teaching (Kusairi, 2020; Onodipe & Ayadi, 2020).

Email and Instant Messaging. This section interprets the data found describing the use of email and instant messaging to accomplish formative assessment tasks. The results are described in terms of asynchronous and synchronous formative assessment activities. The success, failure, and difficulties of use of email and instant messaging in formative assessment tasks is also discussed. Email and instant messaging are asynchronous and synchronous tools, respectively, use for communication of formative assessment activities (Crane, 2017; Khanal, 2021).

Email was a successful tool for individual and private feedback, as well as feedback on independent practice (Khanal, 2021). Group email is a valuable tool for collaborative projects and peer feedback (Kumar & Johnson, 2019). Email, when used in

conjunction with virtual office hours, was found to be successful for specific questions and answers and as a tool to track corrections and changes to documents (Martin et al., 2020; McCorkle & Coogle, 2020). Instant messaging tools talked about in the studied sections include the applications Live Text, WeChat, and WhatsApp (Radoli, 2017; Xu & Peng, 2017).

Microsoft Word. Two tools in MSWord were mentioned by name in two sections included in the studies: Editor and Track Changes. Synonyms or generic terms for these functions, or references to these functions in different programs, were also used in descriptions of tools used in formative assessment activity and communication of formative assessment feedback (Hurtado, 2017; Kumar & Johnson, 2019).

Digital Communication of Formative Assessment Information. This section looks at the results found in the data in the included studies that address the use of digital communication to relay formative assessment information. The results are examined through the types of feedback used and the temporal aspect of the feedback. The differences, similarities, and difficulties of use of digital communication of formative assessment information is also examined. Feedback was the most commonly used theme for formative assessment activity, but the information involved in providing feedback, and changing learning used several different methods of communication. Blogs, wikis, discussion boards, chat, and coaching were all discussed as methods of communicating digitally formative assessment information (Radoli, 2017). Types of feedback discussed were constructive feedback, immediate feedback, timely feedback, personalized feedback, instructor feedback, peer feedback, student feedback, and, of course categorized as asynchronous or synchronous feedback.

Differences in exploring the differences between types of feedback, and

similarities were also found. Asynchronous audio-visual discussions were found to be similar to discussion board threads, but with richer content (Canals et al., 2020). A comparison of asynchronous feedback to synchronous feedback demonstrated that in a synchronous discussion, everyone tends to hear the same message. The convenience of asynchronous resources was found to create successful learning changes in several of the studies (Shang, 2017).

The above section identified technological resources used to perform formative assessment activities. It also described successes and failures of those resources and activities, as well as difficulty found in using those resources and activities. The data described the use of conference software and sites used to carry out assessment activities and change or introduce new learning activities to address deficiencies. Besides commercial conference software and sites, the studies also examined CMS and CMS components as tools to accomplish the formative assessment tasks. Components and functions that were further described include chat, discussion boards, audio and visual presentation tools, social networking sites, mobile devices, email, and instant messaging. The umbrella term of digital communication was examined to present a picture of feedback as the umbrella term for all these components. The descriptions of the differences, similarities, and difficulties of using these tools were further examined by identifying the target of the assessment activity and the impact the digital communication has on that target, which is discussed in the next section.

Research Question 2

This section examines the data that answered Research Question 2. It discusses the flow of information in formative assessment activities, whether it is teacher to student, student to teacher, or peer to peer. The results are used to categorize the

formative assessment information gained through the use of technology as an assessment of concept construction, knowledge construction, skill construction, concept revision, and participation and on task behavior. Information flowing to the students is described as corrective information, critical reflection stimuli, guided instruction, revision information, and skills practice stimuli. This section also delves into the targets of formative assessment tasks such as comprehension, concept acquisition, content retention, skill acquisition, and knowledge acquisition. This section will also examine the positive, negative and neutral impact of the described formative assessment activities. The temporal aspects of the formative assessment tasks, as well as the success or failure of those activities, is looked at in this section. This section describes the temporal aspect and the delivery type of the formative assessment information discovered in these activities. Information may be delivered through audio, visual, and audio-visual media, and it may be synchronous, asynchronous, or both.

What formative assessment information do teachers and students gain as the authentic assessment activity is carried out? Formative assessment information travels in several directions. This analysis examined formative assessment communication that flows from student to instructor, from instructor to student, or from peer to peer. In the included studies, instructors received, and acted upon, formative assessment information relating to student progress in concept construction, content revision, skill construction, knowledge construction, and information about on-task behavior and participation. Students received formative assessment information that was corrective information, critical reflection stimuli, guided instruction, revision information, and skills practice stimuli. The above formative assessment information measures the targets of comprehension, concept acquisition, content retention, knowledge acquisition, and skills

acquisition. The studies were examined to see if the data indicated a positive, negative, or neutral impact on the target of the formative assessment activity.

Terms were searched in NVivo, and segments of selected studies were coded if they contained information on feedback as a tool for formative assessment that is either gathered or delivered through the use of technology. General feedback presented varied results depending on characteristics of that feedback. One characteristic that affects the impact of feedback on formative assessment activities is the temporal characteristic. Feedback can be synchronous or asynchronous. Backs (2017) found participation to be the arbiter of any positive impact on formative assessment targets using synchronous feedback in graduate level education. Students who participated utilized the formative assessment tools to achieve the formative assessment targets of skill and concept acquisition. Students who did not actively engage with the formative assessment tools showed no gains related to the targets (Elizondo-Garcia & Gallardo, 2020).

Automated quizzes within a CMS that provided instant feedback containing corrective information and guidance to adjust learning had a positive impact on formative assessment targets in a tutoring flipped classroom. Schmitz (2019) stated, "This study found strong support that formative assessment engagement is positively associated with students' performance measured by summative assessments (*sic*) tests" (p. 4). Quizzes as formative assessment tools can be used to stimulate discussion, as well. Instructors can receive knowledge construction and participation information from a combination of quiz and discussion activity. The feedback that is generated stimulates critical reflection activity in the student population creating a positive impact on progress toward the target of knowledge acquisition (Wilton et al., 2019).

Written feedback that was timely, personalized, and detailed had a positive impact

on the target of knowledge acquisition and provided the instructor with data on student knowledge construction, while providing the student with guided instruction, corrective information, and critical reflection stimuli (Abri, 2021; Hurtado, 2017). Similarly, two-way written feedback had a positive impact on the targets of comprehension and concept acquisition by providing the instructor with information on how students were progressing with concept construction, and, in turn, providing students with information regarding content revision and stimulating critical reflection activities (Abri, 2021). Specific tools, such as Google Docs and Microsoft Word, were discussed as components of successful formative assessment activities.

Using Google Docs, Abri (2021) observed positive impact on the targets of concept and skill acquisition, using the tool for instructors to receive information on student skill construction, content revision, concept construction, and participation. Students receive revised information such as corrective information, and feedback that stimulates critical reflection and skills practice. Instructors stated that generating guides available on the internet helped their students form a plan to complete complex assignments (Ebadi & Alizadeh, 2021) Audio visual feedback was used as a complement in this study and was found to increase the impact on learning and learning changes (McCorkle & Coogle, 2020).

Formative assessment feedback delivered in audio format showed positive impact on the target of skill acquisition by successfully providing corrective information and skills practice stimuli to the student, while giving the instructor information about the skill construction patterns and success of the student (Andújar-Vaca & Cruz-Martínez, 2017; Canals et al., 2020; Chandran et al., 2021). Audio feedback provided via telephone communication and conference call capabilities was successful at impacting the target of

skills acquisition by providing the instructor with information about the skills construction of the adult students, then facilitating the provision of instant, personalized feedback with revision information for the student (Crane, 2017). Once again, feedback delivered through multiple modalities, in this case audio and text feedback, was found to have a positive impact on formative assessment targets (Canals et al., 2020).

Video feedback, which most likely contains an audio component, has also been shown to be effective in delivery of feedback that positively impacts formative assessment targets (Canals et al., 2020; Hojeij & Hurley, 2017; McCorkle & Coogle, 2020). Information provided via video created a positive impact on the formative assessment target of knowledge acquisition by delivering information about students' knowledge construction practices and progress, as well as their participation habits. This led to the use of video to provide feedback that gave the students corrective information that they could act upon. A specific use of video, the video journal, language practice, was found to have a positive impact on formative assessment targets. Video lessons available asynchrnously, combined with surveys, provided instructors with formative assessment information in several areas, allowing for changes in content and activities. Students received various types of formative assessment information that was tailored to their needs (Canals et al., 2020).

Asynchronous video feedback can have a positive impact on the formative assessment targets of concept and knowledge acquisition by providing concept construction and participation information to instructors and being used to provide corrective and revision information to students, stimulating critical reflection activity (Gündüz & Akkoyunlu, 2019). Not all data indicated the use of video having a positive impact on formative assessment targets. Technical difficulties can create a situation in

which the integration of video into formative assessment activities has a negative impact

on formative assessment targets (Gündüz & Akkoyunlu, 2019). Visual feedback

delivered via mobile phone applications in carpentry classes were the subject of an

included study. Instructors and students used visual feedback to provide formative

assessment information to instructors, who would, in turn, provide feedback to students

that enhances concept acquisition and reinforces skills acquisition. The same application

was used for peer-to-peer feedback for similar purposes. The mobile phones were also

used to implement video games that helped with content retention and knowledge

acquisition (Hegarty & Thompson, 2019). Audio-visual feedback was credited with gains

in content retention and knowledge acquisition when it was delivered synchronously in a

study involving students using social media to study languages (Ko, 2019).

Chat activities were examined in several of the selected studies as a way to gauge

learning behavior, check for understanding, and deliver feedback. Chat can be audio,

audio-visual, using the chat function in a CMS, or using a mobile device. Audio-visual

chat sessions using a tool such as Skype have been used to provide instructors with skills

construction information about students. The instructor then can deliver corrective

information and assist students in skills practice, in order to reach the target of skills

acquisition (Bognar & Krumes, 2017; Canals et al., 2020). The chat function in a CMS

live classroom is another tool used to examine skills, stimulate skills practice, and

continue to adjust learning toward the goal of skills acquisition (Soria et al., 2020). CMS

chat functionality includes extra factors that assist in creating a positive impact toward

the target. For example, instructors and students can use the raise hand function,

emoticons, and other humanizing factors to help anchor learning (Soria et al., 2020).

Instructors use chat in online class discussions to provide guided instruction,

helping stimulate critical reflection in students. Instructors also observe chat to check on student concept construction. In these ways, chat in an online class discussion is used as an effective tool in assessing the targets of concept and knowledge acquisition (Thompson et al., 2017). Both the chat function and the discussion board function of CMS have been observed to add extra methods of teaching and learning for students with special needs, or who are shy in classroom settings. These tools can be used to observe student learning and interactive behavior and to provide corrective information to students (Soria et al., 2020). Feedback delivered electronically that is directly related to concept goals that are clearly explained at the beginning of the course can lead to greater concept acquisition for students (Hegarty & Thompson, 2019). A less structured use of real-time audio chat was examined in a study of postgraduate students who use an audio chat program to share information and seek peer suggestions in the postgraduate research process. The data in this study illustrate that peer feedback can prompt gains in both knowledge and skill acquisition (Saeed & Ghazali, 2019).

Asynchronous forms of communication are also used as vehicles for formative assessment activities. Students have expressed that asynchronous feedback is effective in helping them maximize knowledge and content acquisition, because they can access it when it is best for them to do so (Topacio, 2018). Wikis, blogs, and e portfolios are all used as collaborative activities that incorporate formative assessment information gathering, and changes in activities based on that information (Di Gregorio & Beaton, 2019; Hsiao & Huang, 2019; Tur et al., 2019). Blogs have been observed to provide a positive impact on the skills acquisition formative assessment target by allowing the instructor to assess participation and skills construction activity, and, in turn, stimulate skills practice in students (Di Gregorio & Beaton, 2019).

These collaborative activities also allow for peer-to-peer feedback. Constructive peer feedback positively impacts formative assessment targets such as comprehension, concept acquisition, content retention, knowledge acquisition, and skills acquisition. Peer feedback can include corrective information leading to content revision (Shang, 2017). Peer feedback also leads to critical reflection for both the peer reviewer and the receiver of the feedback (Layali, 2017). Skills practice also occurs at both ends of peer review activity.

Hegarty and Thompson (2019) examined the use of Evernote and ePortfolios to deliver both peer-to-peer and instructor-to-student formative assessment feedback. Feedback that was described as concrete was found to create enhanced opportunities for knowledge acquisition. Another study revealed data that showed that timely feedback on ePortfolios was instrumental in raising skill acquisition rates. This was true for peer-to-peer feedback and instructor-to-student feedback (Hegarty & Thompson, 2019). Peer-to-peer feedback in group work resulted in gains in both knowledge acquisition and content retention in a study that found that students constructed a paradigm to organize the knowledge and concepts presented into a concept, using peer feedback as one component of the concept acquisition process (Hsiao & Huang, 2019).

Comparison of peer and self-work allows students to acquire skills and knowledge in language learning according to one study. However, real-time feedback was the most helpful in the knowledge acquisition of vocabulary (Cohen & Williams, 2019; Ko, 2019). Providing feedback to peers created a greater opportunity for critical reflection and comprehension (Cohen & Williams, 2019). Asynchronous feedback was found to be responsible for providing instructors with formative assessment data about comprehension that travels from student to instructor in a study of high school physics

instruction. This information was used by the instructor to plan next steps in changing instruction, as well as what feedback the instructor can give the student to help them change learning activity (Kusairi, 2020). A study of the Turnitin software revealed an opportunity to bring student the concept of attention to unfamiliar topics (Li & Li, 2018). The asynchronous use of reflection journals was examined in a study of courses in science, technology, engineering, and math. The data from that study demonstrated that high-quality and frequent reflective journaling activity among students provided instructors with the information needed to change learning to correct student issues. These educational corrections created improvements in exam scores that represented gains in comprehension and concept acquisition (Menekse, 2020).

Discussion board activities generally had a positive impact on assessing target information in the learning process. Targets of assessments vary in discussion board activities. In the included studies that examined discussion board activities, six of the studies explored concept acquisition and four examined knowledge acquisition, while two of the studies examined the use of discussion boards for skill acquisition. Instructors used the discussion board activity to examine participation and skill construction, then offered corrective information and guided instruction, thus stimulating skills practice for students (Page et al., 2020). Instructors and students used discussion boards to stimulate critical reflection to assist with knowledge and concept construction in eight of the included studies (Backs, 2017; Barkand, 2017; Chen et al., 2020; Easterday et al., 2017; Howell et al., 2017; Hurtado, 2017; Page et al., 2020; Thompson et al., 2017). CMS provide detailed participation information, one way in which instructors can assess student learning behavior (Hurtado, 2017; Thompson et al., 2017).

Low participation turned a positive impact on the assessment target to a neutral

impact on the assessment target in one study (Hurtado, 2017). Participation is important in skills acquisition. Instructors and students examine skills construction and peers work with discussion boards to assess knowledge construction (Backs, 2017; Barkand, 2017; Chen et al., 2020; Page et al., 2020; Thompson et al., 2017). The information gathered is then channeled toward providing the student information regarding content revision (Bollato, 2016), corrective information (Chen et al., 2020), guided instruction (Thompson et al., 2017), and stimulating critical reflection (Thompson et al., 2017). Discussion board activity is also used to assess student concept construction (Easterday et al., 2017; Howell et al., 2017; Thompson et al., 2017). Concept construction assessment information is then used to provide the students with stimuli for critical reflection, thus assisting in achieving the concept acquisition target (Howell et al., 2017; Thompson et al., 2017).

Several studies found feedback delivered through email to have a positive impact on the formative assessment target, while one study found the information delivered through email to have a neutral or no impact on the target (Hurtado, 2017). Hurtado (2017) discovered that instructors received information about student skill construction utilizing email communication, then provided corrective information to the students to work toward the goal of skill acquisition. The asynchronous nature of email was named as a characteristic that made it more effective in the formative assessment process. Hurtado stated, "I've noticed how Mr. Hilaria provided a concrete example through email for Rosalba, which allows her to return to her inbox and review email content anytime" (p. 91).

Some studies posited a comparison of asynchronous versus synchronous paradigm in the use of feedback for formative assessment purposes. Hegarty and Thompson (2019) noted that, for skill construction and content revision information

going to the instructor, as well as for corrective information and revision information that subsequently goes to students, synchronous, real-time feedback works the best. Crane (2017) also noticed an increase in positive impact on the formative assessment target with synchronous communication, with one activity in which the instructor receives the skill construction and content revision information, and immediately provided guided instruction and corrective information to the student, who continues to work toward the targets of content retention and skill acquisition. Synchronous communication provided in an educational game was used for the purpose of targeting content retention and concept acquisition successfully as demonstrated in a 2020 study (Callaghan & Reich, 2020). Similarly, students have reported that real-time, computer-driven feedback in language learning leads to gains in content retention (Klimova & Polakova, 2020).

The above section discussed the information received through formative assessment activities, the target of the formative assessment activity, and the impact on the target of the formative assessment activity. The direction of information flow, such as student to instructor, instructor to student, and peer to peer was described. The targets of the formative assessment activity and resulting feedback were described, including for instructors, concept construction, content revision, skill construction, knowledge construction, on task behavior, and participation. Formative assessment targets of feedback provided to students includes corrective information, critical reflection stimuli, guided instruction, revision information, and skills practice stimuli. Also described were the characteristics of feedback that affect the impact on targets of formative assessment information. Those characteristics involve time, format, activities, and functions used to accomplish the communication. The functions discussed included chat, wikis, blogs, discussion boards, email, social media, and collaborative writing applications. These

targets, activities, and functions are further examined in the next section through a
description of the changes in existing activities, new activities introduced, and the
planning of activities to address needs revealed by formative assessment activity.

Research Question 3

This section examines how instructors and students use formative assessment
information to provide corrective information is the learning process. This section
describes the examples of corrective information activity in the data in the included
studies in relation to student reflection, application of feedback information, and
motivation of student participation and practice. The formative assessment activities are
described in terms of the direction of the flow of the corrective information, from student
to instructor, from instructor to student, and from peer to peer. This section examines the
temporal nature of corrective feedback in terms of asynchronous feedback and
synchronous feedback. Results are examined in terms of the tools used to deliver
corrective information in formative assessment tasks, including chat functions, discussion
boards, email, and wikis.

General Feedback From Peer to Peer. This section examines the use of peer-to-
peer feedback to relay corrective information in formative assessment activities. The
results of the data in the included studies are discussed as to the characteristics of peer-to-
peer feedback that create activities that reach formative assessment goals, and specific
results of those activities. Peer-to-peer feedback creates a reflection loop in which the
student providing the feedback reflections on why they provided the specific feedback
and the student receiving the feedback reflects on their skill and knowledge base. Both
parties are shown to change their learning activities as a result of this reflection
(Meikleham & Hugo, 2020). The data reflect that, in this study, formative assessment and

the resulting changes in learning activity are integrated into the assignment. Richards (2020) discovered that the key cognitive activity created in peer review was analysis, both in the giving and receiving of feedback. Even when feedback was incorrect, the analysis occurred and created a change in learning activities and writing practice.

Instructor involvement in peer feedback activities has shown mixed results in the various studies. Tur et al. (2019) discovered that learning changes were greater in peer feedback assignments when instructor feedback was targeted but limited and the assignment was clearly delineated by the instructor through the use of a rubric. Similar results became apparent in a study of collaborative activity. Students needed the encouragement of instructor grading and feedback to perform substantive peer review activities and to find these efforts effective in changing learning and practice (Mohamadi Zenouzagh, 2019).

General Feedback From Student to Instructor to Student. This section looks at the results of the data related to information that instructors glean about student learning from formative assessment activity, as well as the corrective information provided to the students. The formative assessment activities are described, in this section, as targeting comprehension, concept acquisition, content retention, knowledge acquisition, and skills acquisition. The information instructors receive related to student progress are described in terms of concept construction, content revision, knowledge construction, skill construction, and participation and on task behavior. This section describes the information supplied to students as corrective information, critical reflection, guided instruction, revision information and skills practice.

The instructors use the formative assessment information gained by examining student activity and work to provide corrective information to the student, which leads to

student reflection, then application of the feedback. This process creates skill building and content acquisition. However, this process only works when students actively participate in the process, providing feedback to the instructor by answering questions, handing in assignments, or participating in chats and email conversations. There is some evidence that when the participation is a graded or required part of the course, students participate at a higher rate (Elizondo-Garcia & Gallardo, 2020). These activities reflect changes in learning activities and the inclusion of new learning and teaching activities. Since learning involves classroom content combined with previous knowledge, so base line testing allows instructors to change class content to cover any missing information (DeMara et al., 2019). Formative assessment is used in writing assignments through tools like MSWord, which can be used to give specific feedback to address deficiencies, improving student practice and building student writing skills (Hurtado, 2017). Students described detailed video feedback on projects, that can be viewed at the student's convenience, is even more effective that written feedback for reflection and revision (Canals et al., 2020).

Technology is also used by instructors to track student progress and adjust learning activities and implement new activities when necessary. One study showed the use of an iPod Touch, integrated into the learning activity, and providing formative assessment information that led to changing learning activities throughout the unit to fit the students' learning needs . Another study revealed the benefits of adjusting tutor involvement in activities to just the level where critical reflection was triggered (Li et al., 2019). Tutor feedback can be timely and personalized, but it can be difficult in some situations, such as an open university (Chen et al., 2020).

Feedback from instructors is often where critical reflection activities start, but the

student must own the activity process from there (Martin et al., 2020). This reflection may take place as students review their own work, with feedback on hand to indicate areas for review and revision (Robertson et al., 2019) Writing in stages to check for skill deficiencies and afford the opportunity for correction allows skills to be learned through individualized feedback and revision applied to ongoing work . Progressive writing and revision assignments have been turned into portfolios to show the change in learning and skill and concept acquisition (Tur et al., 2019).

Instructor-to-student feedback is the most productive when it creates a situation in which the student constructs their own learning changes. Coaching, as an instructional method, leads to cognitive activity, such as critical reflection (Layali, 2017). This is an example of formative assessment information and action taken because of that information being integrated into the learning activity. Schmitz (2019) described the use of feedback triggers that are built into the learning activity as a method of using formative assessment to guide timely instruction. Specific feedback given soon after the given during a learning experience creates a situation in which students want to revise their assignment and further desire to change their writing and learning habits (McCorkle & Coogle, 2020). In language learning, one study demonstrated that explicit feedback combined with metalinguistic feedback created the most changes in learning activity and skills gains. Students learned better from correction and an explanation of the mistakes, than just correction itself (Canals et al., 2020). Another study showed that the use of oral assignments with a feedback component led to new speaking exercises (Xu & Peng, 2017).

A common theme in the studies examined was that formative assessment information gathering combined with formative assessment feedback commonly results

in changes in instruction and corrective learning. Web-based timely diagnostic feedback can be used to meet students where they are and help them move forward in learning, therefore employing the zone of proximal development method (Sánchez-Gómez et al., 2017). In many of the studies, a loop of ongoing activity is present. One study examined the use of Schoolology and Word Draft in which the student would turn in an assignment and the instructor would provide feedback several times. The assignment was not done until it was done correctly (Hurtado, 2017). The instructor assesses student learning and provides feedback, and the student reflects on the feedback and revises learning and practice, handing it back to the instructor to assess again (Hurtado, 2017; Sánchez-Gómez et al., 2017; Töman, 2017; Xu & Peng, 2017; Yilmaz, 2017). Instructor-to-student feedback can be slowly pulled back as students build skills and make fewer and fewer mistakes (Layali, 2017).

Students Discovering Their Own Feedback. This section looks at students using technology to discover their own feedback. The results examined are the temporal characteristics of the feedback, as well as the target of the feedback. The tools used to deliver the feedback are also described. Self-grading leads to critical reflection leads to revision. In this case, the assessment target information led to changes in ongoing activities. In a peer review assignment, students were asked to grade themselves on their peer review performance and to describe what they learned by doing the peer reviews. (Elizondo-Garcia & Gallardo, 2020). In large classrooms, instructors have students use clicker-style programs in their mobile phones for instant feedback on understanding, and quick correction of erroneous information (Kent, 2019). Observation of the performance of other students in asynchronous learning can lead students to change learning activities such as participation, feedback to other students, and the cognitive activities that occur

with participation and becoming a feedback provider (Elizondo-Garcia & Gallardo, 2020). Even feedback that may seem summative, such as end-of-term grading and comments on assignments, can be used as formative assessment activities if students are expected to use that information as the beginning of self-development activities (Di Gregorio & Beaton, 2019).

Asynchronous Feedback. Asynchronous feedback is available to be accessed anytime, giving the student the chance to review and reflect on corrective information. Asynchronous feedback allows students time to reflect and change skills and practice (Shang, 2017). Reflection on asynchronous feedback also leads to the introduction of new learning activities and new methods of practicing skills. This leads to internalized revision and self-correction. Feedback close in time to activity leads to changes in practice and learning gains (Töman, 2017).

Low feedback participation or critical feedback with no constructive aspect can discourage practice and learning changes. Useful feedback can change learning through the identification of weaknesses and strengths. Reflective activities to change learning behavior and to achieve skill attainment is built into activities with step-by-step development of reflection activity to continually change learning (Cheng, 2017). Canals et al. (2020) discovered that asynchronous feedback on language activities increased accuracy and encourage practice, which led to a gain in speaking skills. The availability of asynchronous feedback was a major factor in the usefulness of such feedback in creating successes in learning a new language (Shang, 2017).

One-way formative assessment feedback is looked at in this study is by the target action that the feedback is aimed to either correct or instigate. These targets may overlap. In one study, writing activities were planned to be included multiple critiques to improve

practice activity and learning outcomes (Easterday et al., 2017). This process of receiving corrective feedback to instigate review was emphasized in other studies (Abri, 2021; Canals et al., 2020). This creates a loop of activity that includes feedback, review, reflection, and changes in practice or activity (Easterday et al., 2017). This loop can be even more effective if students receive formative assessment feedback from instructors before reviewing, in this case, chat activities, to direct the student to areas of correction in understanding needed through a series of cues (Meikleham & Hugo, 2020). A study by Layali (2017) illustrated that a gradual decrease in correction resulted in greater student involvement and achievement. Directed correction leads to students changing the way they perform the existing activity, grows reflection skills, and assists in correcting existing deficiencies in learning (Bates & Donaghue, 2021).

Reflection, participation, skill acquisition, and knowledge building are activities that were the targets of formative assessment feedback in some of the studies. These activities lead directly to identifying new and changed activities that will help learners reach learning goals. The process of reflection involves students using feedback as a guide to reflection and creation of their own new and changed learning activities (Cohen & Williams, 2019). This leads to new activities such as identifying strong points to reinforce in later writing. Discussions of strong points identified with instructors does even more to reinforce and strengthen writing skills for later assignments (Cohen & Williams, 2019). General discussions of assignments, activities, and skills, as well as topics for analysis, also leads to reflection, and often to new strategies to revise and correct skills practice and choose new activities that will lead to greater learning outcomes (Cheng, 2017).

Skill acquisition in speaking a new language and writing was a target in several of

the studies examined in this analysis (Hurtado, 2017; Shang, 2017). Modeling based on formative assessment information gathered was described as leading to new learning activities in writing in which students began practicing more and deeper levels of description as a result of this feedback (Abri, 2021). Asynchronous access to feedback was found to be more successful in stimulating corrective activity in writing while learning a new language (Shang, 2017), and asynchronous access to recorded tutor feedback afforded students the opportunity to change activities for better learning (Lowenthal et al., 2020).

Participation plays a part in the success of formative assessment corrective activities. Students who have access to offline review of chat sessions have a stronger chance of adopting new strategies for practice (Thompson et al., 2017). If the goal is collaborative participation, then interactive asynchronous feedback is more productive in spurring changes that lead to correcting deficiencies in writing skills (Hsiao & Huang, 2019). Participation in collaborative work for knowledge acquisition in learning a new language was a successful target for formative assessment corrections, as students learned new idioms at a higher rate in a collaborative environment than individually (Abri, 2021). In general, if students choose not to take advantage of formative assessment information and take part in corrective learning activities, then formative assessment is unsuccessful. Students who review, reflect, and rewrite tend to have successful correction of deficiencies in course goals (Abri, 2021).

The direction of feedback is another way that formative assessment activity was examined in this analysis. Peer-to-peer feedback in which students exchange information has been shown to lead to student confidence in changing their own learning activities and engaging in new activities to improve learning (Bartholomew et al., 2019). Peer

feedback in teacher education, based on lesson observation, leads to self-reflection and changes in behavior and learning activity of the student teacher (Töman, 2017). The inaccuracy of peer feedback may not be a barrier to stimulating appropriate changes in learning behavior. The simple act of the feedback discussion can instigate learning activities that enhance the ability to reach learning goals through deeper analysis. These learning goals exist at the levels of comprehension, evaluation, and synthesis (Bartholomew et al., 2019). Peer feedback in subject and skill correction can lead to new peer interaction, creating a chance for reflective activity that leads to new skill and knowledge building activity (Bartholomew et al., 2019). Peer feedback needs to be guided, however, to keep interactions on task and at an appropriate depth of examination to create the reflective learning decisions that are needed to reach the learning goals (Ebadi & Alizadeh, 2021).

Instructor-to-student feedback may be what is generally thought of when discussing formative assessment feedback. In this situation, feedback is triggered by some formative assessment activity, which reveals where changes are needed in the current learning activities or where new activities are needed to address areas in which students might not be reaching learning goals or are a little off track on attaining the learning goal. This feedback is intended to assist the student in changing the learning activity or engaging in a new learning activities that will better help the student to reach the learning goal (Bartholomew et al., 2019). In order for this to work, it must be noted that not all feedback is from instructor to student. Instructors receive feedback from students that causes them to change instruction and content. Student feedback is usually solicited as part of the learning plan to initiate and direct instructor feedback. Student feedback to instructors usually indicates a student desires to receive formative assessment

feedback and direction in a learning activity (Khanal, 2021). One study in this analysis described a learning environment in which formative assessments were tailored to move students from receiving correction passively to actively requesting correction of self-identified learning deficiencies from the instructor (Khanal, 2021).

Constructive asynchronous feedback led to reflection to identify and attempt new and changed strategies in at least two of the studies in this analysis (Sánchez-Gómez et al., 2017). Constructive asynchronous instructional feedback, which the student utilizes for revision of assignments, often leads to students initiating formative assessment activity of their own beyond the course. Ongoing asynchronous feedback leads to skill acquisition (Bartholomew et al., 2019). Feedback provided in most or all activities encourages correction in learning practices and guides the student to the learning goal, according to one study (Figueroa-Cañas & Sancho-Vinuesa, 2021). Students want to utilize corrective feedback to change current learning and implement new learning activities to better achieve learning goals at present and in the future (Canals et al., 2020; Figueroa-Cañas & Sancho-Vinuesa, 2021).

Detailed and timely asynchronous feedback creates an opportunity for skill attainment (Barkand, 2017). Gains go down related to distance in time from the activity (Martin et al., 2020). Summative feedback generally does not lead to new or changed learning activities and rarely leads to reflection activity. Any deficiencies identified in summative assessment apply to skills practice that was occurring in the past without an opportunity to correct the learning activity to address the deficiency. Asynchronous learning activities without feedback, or with just end feedback, were found to create little to no learning changes.

Chat. Chat can take two forms: written and oral. Oral chats can be one on one or

in a group. Oral chats using mobile phones are used in language courses to provide synchronous correction and examples that lead to altered practice activities and skill building. Planned integration of these tools for use in formative assessment and related feedback activities is integral to accomplishing lesson goals (McCorkle & Coogle, 2020). The WeChat application is used for oral assignments with feedback and revision improves both skills in the areas of pronunciation and grammar use and knowledge in the form of content and vocabulary. WeChat is used on mobile phones and students use it daily to change practice activities of listening, speaking, and pronunciation as indicated by the formative assessment feedback received (Xu & Peng, 2017).

Sometimes chat is within a class setting in which the instructor is presenting and students type questions in the chat text box. Students use the chat text box to ask the instructor for clarifying information, which leads to a change in teaching activity, participation, and content. Synthesis lesson goals are more successfully reached when this is a planned part of the formative assessment and related feedback activity (Bin Dahmash, 2021). A course may have two instructors, or tutors, that monitor the text chat and answer questions, providing corrected information that provides for better understanding of instructor presentations in real time (Bin Dahmash, 2021). Chat can be used for coaching which increases cognitive attention in students. Students who were coached in a learner-led chat related to course readings exhibited behavior that indicated cognitive presence more than those not coached. (Bates & Donaghue, 2021).

Students can also provide synchronous chat feedback in a collaborative synchronous environment. Students view the collaborative document, while employing the chat function, to engage in formative assessment feedback and correction activities (Bates & Donaghue, 2021). Though synchronous chat provides for instant correction, the

ability to review chat asynchronously creates a time for reflection, and often greater

changes in learning practices (Bates & Donaghue, 2021; Chandran et al., 2021). Student

familiarity with chat activity in social media lends to the use of chat in online courses to

encourage cognitive presence and can trigger the reflection loop of feedback, review,

reflection, revision (Thompson et al., 2017). Audio chat can be used, as part of a planned

formative assessment checkpoint, for drill and repetition in which grammar practice and

speech correction leads to skill building and content retention (Soria et al., 2020). Chat

can be used for collaboration with corrective feedback leading to changes in practice and

skill building (Soria et al., 2020; Udeshinee et al., 2019).

Discussion Board. Students must engage in order for feedback on discussion

board postings to be meaningful. Instructor effort does not always ensure student

engagement. The best way to ensure student engagement in this study was to plan a

baseline formative assessment of student knowledge of the use of discussion boards and

discussion board assignments and expectations, then provide instruction to help the use

the discussion board to their best advantage (Elizondo-Garcia & Gallardo, 2020; Page et

al., 2020). If students do not participate, then no changes in learning or new learning

activities occur. However, when instructors diagnosed and met student learning needs in

discussion board skill acquisition, participation and learning goal attainment occurred .

Experience with discussion board activities makes a difference in participation and

resulting learning gains from activity that includes reflection, analysis, revision, and a

repetition of the process (Elizondo-Garcia & Gallardo, 2020). Proper use of discussion

board activities includes students utilizing feedback for critical reflection and content

analysis creating cognitive activity at a higher level than previously achieved (Page et al.,

2020).

Courseware that allows for anchoring in discussion board component allows instructors to choose part of the text or readings as the target of the discussion board posts and keeps students on topic. This creates an environment where students are able to exchange ideas and feedback and collaborate to develop and refine concepts and knowledge (Page et al., 2020). Students can share their answer to the anchored topic, receive feedback, and build on that information, as well as other presentation of the material, such as face-to-face classroom, to create scaffolded learning. Including a writing plan in student discussion board activities allows for scaffolded feedback, which allows the students to build on what they already do well and correct that which is incorrect. Feedback on the subsequent rewrite can cement the corrections and allow for further revisions if needed (Easterday et al., 2017). Instructors plan prompts to provide guidance and correction for posts, as well as model posts that provide a valuable example of how to post on a discussion board (Page et al., 2020).

Instructors often provide a Discussion Board section that is dedicated to seeking feedback from students in the form of questions about assignments, areas that are confusing, or just suggestions for changes in learning activities and content (Crane, 2017; Kebble, 2017). This allows instructors to customize instruction to best meet student needs. Instructors may change existing activities or plan new activities to meet the deficiencies discovered (Elizondo-Garcia & Gallardo, 2020). New types of practice exercises, more question-and-answer sessions, presenting scenarios, or simply modeling proper discussion board skills might be employed (Crane, 2017). Grouping of discussion board students, with a summary of all activity provided so that all students can observe the feedback provided, is also utilized to create a change in learning activity that best helps each student reach the learning goal (Crane, 2017; Kebble, 2017). Instructors must

also plan for students to have a positive experience with software that is necessary for learning. This plan needs to include tutorials and formative assessment to ensure student ability and comfort with the software. Instructors who plan and execute this find students that are motived to learn the technology and also who will participate in the planned activities using that technology (Page et al., 2020).

Email. The most common use for email in the studies examined is to check on progress of individual students and to provide instruction to meet that student's needs (Crane, 2017; Hurtado, 2017). Instructors may take formative assessment information obtained from one or more specific students as an indication to change activities for the entire class (Crane, 2017), or they may use email to create one on one correction, allowing students the opportunity for revision, creating skill building and the acquisition of new learning tools. This type of one-on-one learning through email is an efficient method of scaffolding in online courses (Hurtado, 2017). Hurtado (2017) stated the following:

> Not only did Josue rely on email communication to read his teacher's comments
> and feedback in regards to his essays, he applied his digital and language skills to
> engage in the revision process by using the digital editing tools available to him.
> (p. 94)

Using email conversations as a built-in part of an online course ensures that students receive the information they need, whether it be explanations or supplemental materials, to successfully achieve course goals (McCorkle & Coogle, 2020).

Synchronous Feedback. Formative assessment information and resulting feedback is used to impact learning and teaching practices in several ways. It can be used for out-of-class work, for encouraging participation, and for class discussion. Sometimes

synchronous communication is used in conjunction with asynchronous communication to impact learning (Chandran et al., 2021; Udeshinee et al., 2019). An instructor in a study of adult education stated the following:

> Usually my university classes (masters and doctoral) design, peer review, test, rapid prototype, test and evaluate their designs for learning. This means interlacing sync and async events as students require, along with providing 'lecture' videos linked to specific Q&A discussion threads and living (Google) documents. (Crane, 2017, p. 111)

Students may provide instructors with information about their learning outside of class. Instructors evaluate this information and provide corrective information during the online class. Synchronous correction can create synchronous student learning (Udeshinee et al., 2019). Constructive, real-time correction, often with students taking contemporaneous notes, leads to student reflection and review activities asynchronously, which then leads to the student attaining the learning objective (Sánchez-Gómez et al., 2017).

Synchronous online methods that use formative assessment to drive the learning activity include modeling, simulations, clicker style quizzes, and group discussions (Crane, 2017; Yilmaz, 2017). Synchronous question-and-answer sessions allow students to change direction in response to directed instructor questions or instructor answers to specific questions presented by students (Töman, 2017). Using student response systems allows instructors to analyze student mistakes in real time and adjust teaching accordingly (Kusairi, 2020; Sahin, 2019). Instructors teaching foreign languages plan synchronous sessions in which students can receive real-time constructive feedback to help them cement language learning skills (Udeshinee et al., 2019). Synchronous constructive feedback leads to internalization of language learning skills, creating a more

automatic speaking style (Udeshinee et al., 2019). In music education, the benefit of real-time correction has been noted as well. A study of the use of e-tutorials in undergraduate music courses provided data that demonstrates how instructors use real-time data about each student's learning to address needs by weaving new material into the course. Planning is an important component in the success of using e-tutorials as formative assessment tools (McGuinness & Fulton, 2019).

Some instructors have adapted their face-to-face style of communication to work in an online environment (Crane, 2017). Instructors use synchronous online sessions to remediate, presenting smaller units of material interspersed with student discussion to check for understanding (Chandran et al., 2021). Instructors can plan for less and less synchronous formative assessment correction as students gain skills to reflect and find their own answers. Synchronous tutoring, coaching, and teaching all utilize formative assessment information and real-time feedback to guide students in refining their learning processes (Yilmaz, 2017). Instructors can use information gathered in real time to create the appropriate reflective activities (Thompson et al., 2017).

Wikis and Peer Collaboration. Google Docs, wikis, blogs, online meeting software, and CMSs are used in student collaborations to share feedback, revise, and create student work, all of which are discussed in greater detail in other sections of this document (Machajewski, 2017; Sánchez-Gómez et al., 2017). The change brought about by the assessment target information is discussed here. Peer collaboration, using Google Docs, wikis, and blogs, tends to be useful when a loop of behavior is present that includes writing, peer review, reflection, feedback, revise, peer review, and so on (Chandran et al., 2021; Machajewski, 2017). The synchronous use of chat and collaboration tools within CMSs allows for learning to change through discussion, which leads students to review

concepts and content and to integrate changed concepts in real time. Functions that do not integrate well with the CMS can limit the ability of students to adopt new or changed learning activities in response to formative assessment feedback (Udeshinee et al., 2019). Wikis often employ both synchronous and asynchronous collaboration that facilitates growth in learning style and interpersonal skills as feedback prompts the student to change practice, attain new skills, and acquire new content knowledge (Ko, 2019; Li & Li, 2018; Sánchez-Gómez et al., 2017).

The above section described whether the target information discovered in formative assessment activities utilizing technology led to new learning activities, changes in existing learning activities, and whether those formative assessment activities and resulting adjustments are part of the original plan for the learning activities. The question is answered by examining feedback from instructor to student, student to instructor, and peer to peer. The targets of the formative assessment activity are the information sought by instructors and students to track and analyze student progress on achievement of learning goals to adjust learning to increase success in attaining those goals. The conditions in which formative assessment activity is successful or not successful in instigating new learning activities are described according to the themes defined earlier in the study. The formative assessment conditions that instigate changes in existing learning activities to better achieve learning goals are described above. The themes, which are tools, include asynchronous and synchronous feedback, chat function, email function, discussion board function, wikis, and peer collaboration.

Recommendations

This chapter reported the results of the content analysis of 100 reports on studies in academic journals, 27 dissertations, and two reports to describe the technological

methods and tools that instructors and students use to achieve formative assessment goals. Taxonomic analysis of these studies revealed the tools used were conference software, CMSs, audio, video and presentation software, simple notification services, mobile devices, email, instant messaging, interactive tools, and tutorial sessions.

Instructors and students utilized various conference software and sites to assess student performance and needs. Functions within the conference tool appeared to be the factor that impacted the success of the formative assessment activity. Online meetings were described in terms denoting success when the chat function and document sharing were used successfully. The most common reason reported for success using conference software was ease of use or user familiarity with the tool (Hegarty & Thompson, 2019). This would indicate that part of course planning should include a primer on the use of technological tools proposed to be used in the course.

CMSs and their components are important tools used by instructors and students to accomplish formative assessment tasks. The two most discussed components used in formative assessment activities were the chat function in live, distance learning and the discussion board used in an asynchronous manner. Once again, students and instructors who were familiar and comfortable with the tools being used described the activities as successful most often (Hegarty & Thompson, 2019). Once again, the need for training in the use of these tools was cited as a common need.

The chat function within a CMS was examined in several studies for use in formative assessment tasks. Several difficulties were found in the use of the chat function, such as off task behavior, lack of typing skill, and no facial cues (Chandran et al., 2021; Udeshinee et al., 2019). Other studies reported that emoticons helped alleviate the problem of lack of facial cues (Bates & Donaghue, 2021; Bognar & Krumes, 2017).

Analysis of the information from the included studies indicated that instructor attention to the chat activity during synchronous classes is important. Chat may not be the preferred communication mode of all students. Use of the raise hand function allowed students who were not comfortable communicating in chat to have questions answered (Izmirli & Izmirli, 2019).

Discussion boards were examined for their use in feedback and reflection, two important formative assessment features. Analysis of the information in the studies examined showed that instructor planning and input were the factors that created success in the use of discussion boards (Elizondo-Garcia & Gallardo, 2020). Instructor input must be balanced with the need for students to reflect and participate in discussion board activities (Page et al., 2020). Feedback on discussion board postings, both instructor and peer, led to higher comprehension and concept application (Easterday et al., 2017; Sánchez-Gómez et al., 2017).

Participation is a key factor in discussion board activities and changes in learning (Barkand, 2017). Instructors should use specific subjects and questions to encourage participation (Barkand, 2017). Original posts and responses need to be required for the greatest gains in comprehension and concept acquisition. Instructors need to provide the proper input to keep posts on topic (Page et al., 2020). Another difficulty in the use of discussion boards found was that students did not always participate in a uniform, regular pattern (Elizondo-Garcia & Gallardo, 2020). Discussions need to be included in the syllabus as required assignments with clear goals and objectives.

Simple notification services were used to provide feedback and exchange corrective information in several of the studies. Students preferred sites that they were familiar with, such as Facebook (Hegarty & Thompson, 2019). Facebook was also

preferred because smartphone access made it always available (Ko, 2019). The major

drawback to using Facebook for assignments involved distractions (Hegarty &

Thompson, 2019). Instructors can overcome the distraction factor by using other simple

notification services or using collaborative software in which space can be created solely

for use with the lesson.

Mobile devices were successfully used as tools in technology assisted formative

assessment activities. The most commonly mentioned mobile devices in the formative

assessment activities studied were the iPad and mobile phones (Andújar-Vaca & Cruz-

Martínez, 2017; Giang, 2017; Hegarty & Thompson, 2019; Reeves et al., 2017; Yilmaz,

2017). Factors that instructors can include to help insure success in the use of mobile

devices in formative assessment tasks are timeliness, high-quality feedback, and the

ability of the student to access that feedback at convenient times and wherever the student

is located (Klimova & Polakova, 2020; Ko, 2019). The iPad was found to be successful

in a specific program named Starfall (Reeves et al., 2017). The iPad was also successfully

used for audio feedback (Li et al., 2019).

Digital voting systems were found to be successful at assessing knowledge among

large groups of students and changing teaching strategy accordingly. Participation went

up in classes that used digital voting systems or Plickers (Zuhrieh & Sara Abd Al, 2020).

Mobile phones could be used in place of clickers with little cost to the institution.

Classroom response systems are applications used on smartphones that have replaced

clickers in many classrooms (Onodipe & Ayadi, 2020; Yilmaz, 2017). Instructors can use

these applications to check student learning and adjust teaching (Kusairi, 2020; Onodipe

& Ayadi, 2020).

Email was a successful tool for individual and private feedback (Crane, 2017;

Khanal, 2021). Group email is a valuable tool for collaborative projects and peer feedback (Kumar & Johnson, 2019). Email, when used in conjunction with virtual office hours, was found to be successful for specific questions and answers and as a tool to track corrections and changes to documents. Less successful characteristics of email were the ability to address common errors for multiple students, and lack of timeliness This can be overcome by the use of CMS components or other software used for group communication (Hurtado, 2017). Difficulties with email were found in communities without common internet connection, especially internationally (Khanal, 2021). In order for email to be a successful tool, all students and instructors must have reliable internet. Instructors must answer emails in a timely manner, and students must be expected to do the same.

Blogs, wikis, discussion boards, chat, and coaching were all discussed as methods of communicating digitally formative assessment information (Bognar & Krumes, 2017; Hegarty & Thompson, 2019; Radoli, 2017; Sánchez-Gómez et al., 2017). Differences In exploring the differences between types of feedback, similarities were also found. Instructors used asynchronous audio-visual discussions to accomplish similar goals as lessons utilizing discussion board threads (Khanal, 2021). Instructors need to ensure that students are receiving the information needed accurately.

Across the various studies, several factors were recognized in many of the studies as crucial to the success of formative assessment tasks utilizing technology. Timeliness was one of the most often mentioned factors. Successful instructors were able to gauge the level and frequency of feedback needed to ensure successful formative assessment activity. Detailed, specific, and personal feedback created successful learning changes. Choices were made about the use of synchronous and asynchronous activities. Finally,

important planning decisions were made to choose the modality of the delivery of formative assessment information in terms of audio feedback, video feedback, and written feedback.

In summary, this study attempted to assemble and analyze data from informative studies, conducted regarding formative assessment, and how teachers utilize technological resources in performing formative assessment activities. This information is compiled and analyzed in this qualitative content analysis in hopes of it being helpful to educators and others who are facing the challenge of knowing what students know and how they are learning, utilizing technological tools, especially in a time when distance learning is becoming more prevalent.

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Appendix A

Databases Searched

Databases Searched

- Applied Social Sciences Indexes and Abstracts found at

  - http://search.proquest.com.ezproxylocal.library.nova.edu/assia/advanced?a

    ccountid=6579&language=def&trials=hide

- Education Source – EBESCO host found at

  - http://web.ebscohost.com/ehost/search/advanced?sid=002aa064-7dda-

    492f-99ba-1c5cddc3772d%40sessionmgr112&vid=0&hid=125

- Eric-ProQuest found at

  - http://search.proquest.com.ezproxylocal.library.nova.edu/eric/advanced?ac

    countid=6579

- ProQuest Dissertations and Theses Global found at

  - http://search.proquest.com.ezproxylocal.library.nova.edu/pqdtglobal/adva

    nced?accountid=6579&trials=hide

- ProQuest Dissertations and Theses at Nova Southeastern University found at

  - http://search.proquest.com.ezproxylocal.library.nova.edu/pqdtlocal100625

    5/advanced?accountid=6579

Appendix B

Coding Pilot Articles

Coding Pilot Articles

Item 1

Name	Nodes	References
Alrushiedat, N., & Olfman, L. (2014). Anchoring for Self-Efficacy and Success: An Anchored Asynchronous Online Discussion Case. Journal of Information Systems Education, 25(2), 107-116.	6	38
Blau, I., Mor, N., & Neuthal, T. (2013). Interacting for Learning: Digital Portfolios for a Learning Community in a University Course. Learning, Media and Technology, 38(3), 241-255.	6	22
Ching, Y.-H., & Hsu, Y.-C. (2016). Learners' Interpersonal Beliefs and Generated Feedback in an Online Role-Playing Peer-Feedback Activity: An Exploratory Study. International Review of Research in Open and Distributed Learning, 17(2), 105-122.	5	12
Ching, Y.-H. (2014). Exploring the Impact of Role-Playing on Peer Feedback in an Online Case-Based Learning Activity. International Review of Research in Open and Distance Learning, 15(3), 292-311.	3	11
Comer, D. R., & Lenaghan, J. A. (2013). Enhancing Discussions in the Asynchronous Online Classroom: The Lack of Face-to-Face Interaction Does Not Lessen the Lesson. Journal of Management Education, 37(2), 261-294.	6	121
de Jong, N., Verstegen, M. D., Tan, E. F., & O'Connor, J. S. (2013). A Comparison of Classroom and Online Asynchronous Problem-Based Learning for Students Undertaking Statistics Training as Part of a Public Health Master's Degree. Advances in Health Sciences Education, 18(2), 245-264.	6	52
Ho, M.-c. (2015). The Effects of Face-to-Face and Computer-Mediated Peer Review on EFL Writers' Comments and Revisions. Australasian Journal of Educational Technology, 31(1), 1-15.	6	76
Horstmanshof, L., & Brownie, S. (2013). A Scaffolded Approach to Discussion Board Use for Formative Assessment of Academic Writing Skills. Assessment & Evaluation in Higher Education, 38(1), 61-73.	4	53
Jones, N., Georghiades, P., & Gunson, J. (2012). Student Feedback via Screen Capture Digital Video: Stimulating Student's Modified Action. Higher Education: The	4	17

International Journal of Higher Education and Educational Planning, 64(5), 593-607.		
Koorsse, M., Olivier, W., & Greyling, J. (2014). Self-Regulated Mobile Learning and Assessment: An Evaluation of Assessment Interfaces. Journal of Information Technology Education: Innovations in Practice, 13, 89-109.	4	36
Lai, C.-H., Liu, M.-C., Liu, C.-J., & Huang, Y.-M. (2016). Using Positive Visual Stimuli to Lighten the Online Learning Experience through in Class Questioning. International Review of Research in Open and Distributed Learning, 17(1), 23-41.	6	80
Lin, J.-W., Lai, Y.-C., & Chuang, Y.-S. (2013). Timely Diagnostic Feedback for Database Concept Learning. Educational Technology & Society, 16(2), 228-242.	4	44
Luo, H., Robinson, A. C., & Park, J.-Y. (2014). Peer Grading in a MOOC: Reliability, Validity, and Perceived Effects. Journal of Asynchronous Learning Networks, 18(2), 14.	2	5
Madland, C., & Richards, G. (2016). Enhancing Student-Student Online Interaction: Exploring the Study Buddy Peer Review Activity. International Review of Research in Open and Distributed Learning, 17(3), 157-175.	5	9
McKeown, D., Kimball, K., & Ledford, J. (2015). Effects of Asynchronous Audio Feedback on the Story Revision Practices of Students with Emotional/ Behavioral Disorders. Education and Treatment of Children, 38(4), 541-564.	4	31
McKnight, K., O'Malley, K., Ruzic, R., Horsley, M. K., Franey, J. J., & Bassett, K. (2016). Teaching in a Digital Age: How Educators Use Technology to Improve Student Learning. Journal of Research on Technology in Education, 48(3), 194-211.	5	27
Reddy, D. M., Pfeiffer, H. M., Fleming, R., Ports, K. A., Pedrick, L. E., Barnack-Tavlaris, J. L., . . . Swain, R. A. (2013). "U-Pace" Instruction: Improving Student Success by Integrating Content Mastery and Amplified Assistance. Journal of Asynchronous Learning Networks, 17(1), 147-154.	3	12
Shintani, N. (2016). The Effects of Computer-Mediated Synchronous and Asynchronous Direct Corrective Feedback on Writing: A Case Study. Computer Assisted Language Learning, 29(3), 517-538.	5	61
Tay, L. Y., Lim, C. P., Nair, S. S., & Lim, S. K. (2014). Online Software Applications for Learning: Observations from an Elementary School. Educational Media International, 51(2), 146-161.	3	25

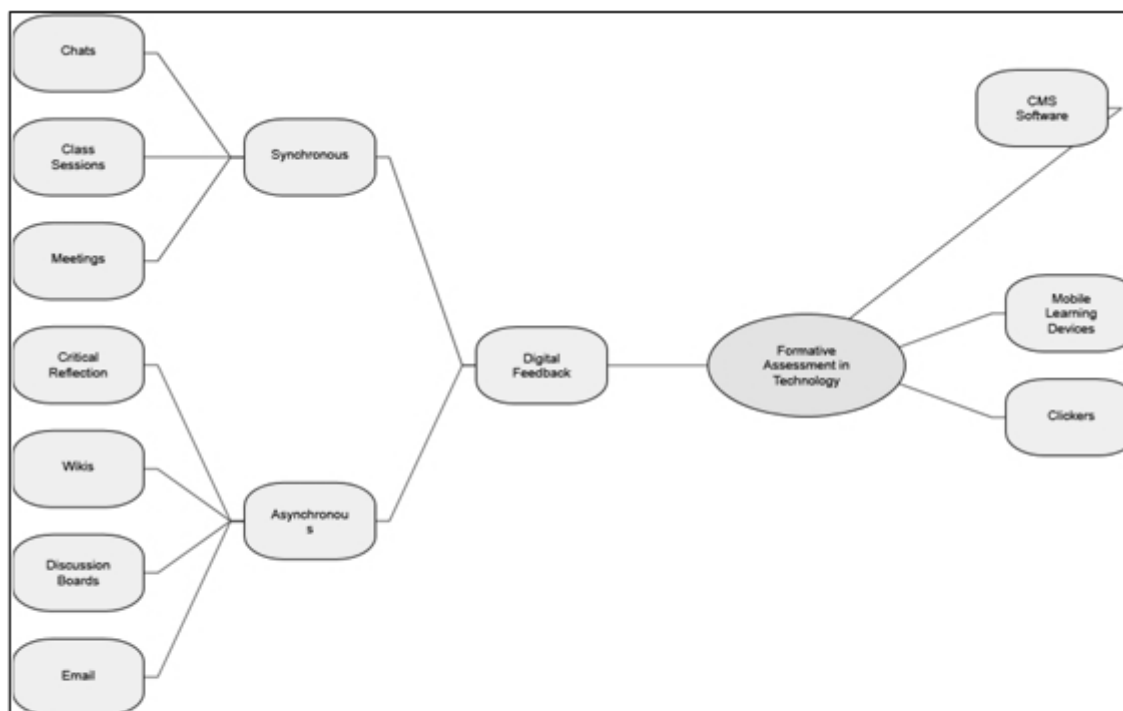| Wijtmans, M., van Rens, L., & van Muijlwijk-Koezen, J. E. (2014). Activating Students' Interest and Participation in Lectures and Practical Courses Using Their Electronic Devices. Journal of Chemical Education, 91(11), 1830-1837. | 4 | 27 |

Item 2

Figure 1. Themes identified in literature review and used in taxonomic analysis.

Appendix C

Technology tools Used in Formative Assessment

Technology tools Used in Formative Assessment

ABRI_2021	Wiki
CRANE_SYNCHRONOUS_2017	App Sharing function
ASIKSOY_2018	Clickers
BACKS_SELFEFFICACY_2017	Interactive tools
	Mind Tap
BARKAND_LMS_DISSERTATION_2017	LMS
BARTHOLOMEW_2019	Rubric
BATES_2021	Chat function
BIN_DAHMASH_2021	Blackboard LMS
CANALS_2020	Chat function
CHANDRAN_2020	Chat function
CRANE_SYNCHRONOUS_2017	Chat function
	LMS
	Online quiz function
	Video
	Whiteboard
DALBY_2019	iPad
DEMARA_2019	Canvas
DIGREGORIO_2019	Blogs
EBADI_2021	Blogs
	Wikis
	Google docs
	Google tools
FIGUEROA-CANAS_2021	Digital quizzes
GAFNI_MOBILE_2017	Duolingo
	MALL
GIANG_IPAD_2017	iPad
HEGARTY_2019	Mobile Devices
HOJEIJ_FLIP_2017	Edmodo
	Powtoon
HURTADO_LMS_2017	Email
	Focal
	MS Word Editing
	MS Word Track Changes
	Schoolology
KHANAL_2021	Canvas
	Email
	Zoom
	Text
KUSAIRI_2020	TryOut
	Webvoting
LOWENTHAL_VIRTUALOFFICEHOURS_2017	Video Conference

	virtual office hours
MCCORKLE_2020	Email
	Text
	Video
	Chat
RADOLI_COLLABORATION_2017	Blackboard LMS
	GroupMe App
	iMessage app
	mobile devices
	What's App
REEVES_FEEDBACK_2017.asp	iPad
ROBERTSON_2019	Automated quizzes
SCHMITZ_2019	e-book portal
SORIA_2020	WhatsApp
	Chat
	Emojis
TUR_2019	Eportfolio
UDESHINEE_2019	Chat
VASQUEZ_SYNCHRONOUS_2017	Chat function
	Interactive tools
	Raise hand icon
WILTON_2019	Integrated assessment
XU_FEEDBACK_2017	MALL
	WeChat
YILMAZ_LEARNERCENTERED_2017	Clicker
	Mobile phone

Appendix D

Technology tools Used for Asynchronous and Synchronous Feedback

Technology tools Used for Asynchronous and Synchronous Feedback

Study Identifier	Resource
CANALS_2020	Screencasts
	Text
	Audio_visual
	Video chat
CHANDRAN_2021	Audio-visual
	Chat
CRANE_SYNCHRONOUS_2017	Adobe Connect
	Conference call system
	Corner Stone
	Google Hangouts
	Social Media
	WebEx
DeMARA_2019	Canvas
FIGUEROA-CANAS_2021	Automated quizzes
OLESOVA_2017	Canvas
ROBERTSON_2019	Automated quizzes
RADOLI_COLLABORATION_2017	Blackboard Discussions
	Blackboard Wikis
	Drop Box
	Google Drive
	Google Hangouts
	GoToMeeting
	Text
VASQUEZ_2017	Audio
	Vide
	Screen Sharing

Appendix E

Technology-Aided Activities Used for Asynchronous and Synchronous Feedback

Technology-Aided Activities Used for Asynchronous and Synchronous Feedback

Study Identifier	Activity
BINDAMASH_2021	Feedback
CRANE_SYNCHRONOUS_2017	Practice
CANALS_2020	Feedback audio
	Feedback video
CHANDRAN_2021	Feedback audio
	Feedback visual
FIGUEROA-CANAS_2021	Automated quizzes
MARTIN_2020	Feedback
RADOLI_COLLABORATION_2017	Collaboration
ROBERTSON_2019	Automated quizzes
SCHMITZ_2019	Guided instruction
TATSANAJAMSUK_2021	Feedback
WILTON_2019	Guided Instruction

Appendix F

Themes and Tools Utilized in Formative Assessment Activities

Themes and Tools Utilized in Formative Assessment Activities