

2016

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Pelech, James R. Dr.. (2016). Comparing the Effectiveness of Closed-Notes Quizzes With Open-notes Quizzes: Blending Constructivist Principles With Action Research to Improve Student Learning.. *i.e.: inquiry in education: Vol. 8: Iss. 1, Article 5*.

Retrieved from: <http://digitalcommons.nl.edu/ie/vol8/iss1/5>

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i.e.: inquiry in education is published by the Center for Practitioner Research at the National College of Education, National-Louis University, Chicago, IL.

Comparing the Effectiveness of Closed-Notes Quizzes with Open-Notes Quizzes

Blending Constructivist Principles with Action Research to Improve Student Learning

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Introduction and Background

In an effort to improve student performance and learning, I have often focused on the effectiveness of different class activities. In particular, in the fall of 2011, I undertook an action research project examining the effect of quiz platforms. The platforms included (a) traditional closed-book, paper, and pencil; (b) white board with collaboration (students worked with a partner, came to a consensus, and then wrote the answer on the white board); and (c) PowerPoint quizzes with no collaboration (quiz questions were shown on a screen via a PowerPoint platform). Students rated the effectiveness on a Likert scale and then explained their rankings with a few sentences.

The quantitative data regarding the traditional format indicated that most students felt that this format was effective; the qualitative data, while mostly supportive of this platform, did provide some alternatives such as being open to other formats and having the opportunity to orally explain answers.

The quantitative data for white board quizzes with collaboration indicated that, in general, students felt this platform was effective for learning. The qualitative data presented positive and negative results. Positive comments included the opportunity to discuss answers with partners, the possible improvement of scores through collaboration, becoming more confident through collaboration, and instant feedback. Negative comments included not being able to come to a consensus, feeling pressured to come to a consensus, and the possibility that students may not read the material and would “ride the coattails of others.”

The results for the PowerPoint quizzes indicated that students had mixed emotions. Students liked the use of technology, the change of pace, and the visual style of this platform; however, they were concerned about changing slides before students were finished with the question, finishing a question but having to wait for me to change slides, and not being able to go back to a question at one’s discretion.

After analyzing the data, I decided to (a) continue using traditional closed-notes quizzes and (b) discontinue the practice of white-board quizzes with collaboration and PowerPoint quizzes. In 2015, I conducted another study based on this revised approach. The rationale, approach, and results are reported here.

Rationale for Study

My rationale in conducting this study was twofold. I use the Constructivist philosophy in my teacher education classes, and this involves students actually experiencing a concept and then reflecting on it; hence, the students needed to experience open-notes quizzes. Yet the research presented in the literature does not present a clear picture of whether this quiz format is more effective than the traditional closed-notes format. This study addressed the situation by using an action research platform in which students were exposed to both formats.

Research Questions

I decided to continue with the traditional closed-notes format for quizzes, but I connected the concepts of quiz platforms as tools for active learning with open-notes quizzes. The overarching research question was as follows:

- How can closed-notes quizzes and open-notes quizzes enable students to learn?

I also identified three related questions:

- From the perspectives of undergraduate students, what quiz platforms are the most effective for enabling them to learn course material?
- From the perspectives of undergraduate students, what are the reasons for the effectiveness of certain types of quiz platforms?
- How can an instructor enable students to learn by utilizing different quiz formats?

Literature Review

To set the background for my study, I performed a literature review on the use of quizzes, action research, and Constructivism. For well over a century, psychologists have studied the effects of testing on academic achievement and on memory. Various student groups have been studied based on age, ethnicity, and other factors. I found numerous articles that helped guide me in my study.

Test Frequency

Bangert-Drowns, Kulik, and Kulik (1991) found that students who had at least one test during a 15-week semester scored higher on criterion examinations than students who did not take a test during that period. Similarly, the meta-analysis of Phelps (2012) indicated that testing with feedback was effective.

Quiz frequency had positive effects on 136 middle school science students (McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011). With a multiple-choice format, review quizzing produced the greatest increases in exam performance, with the benefits of quizzing over no quizzing persisting throughout the semester.

Shirvani (2009) studied 69 Hispanic students in a geometry class and compared students who took a daily quiz with students who did not. The treatment group received a 10-minute daily quiz at the end of class, while the control group received a 10-minute worksheet. The results showed that the daily quiz group improved on both math and homework scores.

Quizzing was also found to be effective at the undergraduate level. Haigh (2007) found that regular quizzes done at the beginning of class or at the end of a break are popular with students and correlated significantly with examinations, journals, and presentations.

The effects of unannounced quizzes were proven beneficial for midrange undergraduates (Graham, 1999). This study compared exam grades of students who took quizzes with those of students who did not take quizzes. Students who took quizzes not only scored higher, but attitude surveys revealed that students were accepting of the quizzes. A study by Hodges et al. (2015) also demonstrated the effectiveness of quizzing for college-level students. The study suggested the following advantages of quizzing: (a) prepares students for deep discussions; (b) encourages higher level questions; and (c) enables the instructor to include higher level questions on exams.

Despite this evidence of the effectiveness of frequent quizzing, however, the results are not conclusive. For example, a study of Iranian high school students who were studying English found that students who experienced frequent and semifrequent English tests had lower mean scores on their final achievement scores their second year than in their first year (Ramshe, Barati, & Youhanaee, 2014). Holt, Young, Keetch, Larsen, and Mollner (2015) studied 1,114 undergraduate students in biology courses for nonmajors. Their results indicated that student improvement in critical thinking was not explained by higher level cognitive thinking required by quizzes.

Quizzing and Cognitive Action

Research has shown that when students take a quiz or test, cognitive action takes place that enables learning. McDaniel, Anderson, Derbish, and Morrisette (2007) and Roediger and Karpicke (2006) refer to the “testing effect,” a phenomenon in which material previously studied and recalled successfully will be better remembered in the future. Expanding on that idea, Agarwal, Roediger, McDaniel, and McDermott (2013) discuss the concept of “retrieval practice.” Retrieval practice focuses not on “getting information in” but on “getting information out.”

Open-Book and Open-Notes Quizzes

The effects of open-book testing are inconclusive. Benefits include sorting out, prioritizing, and integrating course material. Moore and Jensen’s study (2007) revealed that open-book exams do not promote long-term learning. Testing via an open-book format, while yielding better initial performance than a closed-book format, did not have a long-lasting effect (Agarwal, Karpicke, Kang, Roediger, & McDermott, 2008). Additionally, Heijne-Penninga, Kuks, Hofman, and

Cohen-Schotanus (2010) found that open-book tests did not stimulate a deep learning approach. A somewhat similar effect was found by Li (2013), with long-term retention between the two formats being insignificant. Most recently, in comparing the effects of an open-book examination versus a closed-book format, Leung et al. (2014) found that the two formats did not show any significant difference.

The use of so-called crib sheets, or open-notes quizzes, also had mixed reviews in the literature. In a 2005 study, Dickson and Miller found that the authorized use of crib sheets, while reducing test anxiety, did not improve exam performance. Duncan (2007) found no significant difference between open-notes and closed-notes sections. Moreover, Dickson and Bauer (2008) found that students do not learn material as well when they expect to use a crib sheet. On the other hand, the work of Drake et al. (1998) indicated that the use of crib sheets decreased test anxiety. And Weimer (2013), using anecdotal information, examined the effectiveness when students create “crib sheets.” Her conclusion was that creating these aids results in student learning.

Methodology

To understand student perspectives on how they learn, I needed to select a methodology which examines the learning process as it unfolds. Mills (2003) noted the challenges involved: “In classroom and school settings, however, it is difficult to control all of the factors that affect the outcomes of our teaching without disrupting the natural classroom environment” (p. 3). Several other researchers have reiterated this point. For example, Hendricks (2009) stated that context cannot be controlled “but is studied so the ways in which context influences outcomes can be understood” (p. 3); and Efron and Ravid (2013) noted, “As practitioners we also realize the limitations of implementing generalized principles and the shortcomings of applying universal theories to our practice” (p. 3).

One approach that does help alleviate these concerns is the action research platform, which I used for this study. I was motivated in part by two observations. As McNiff and Whitehead (2006) stated, “Action research is a form of enquiry that enables practitioners everywhere to investigate and evaluate their work” (p. 7); and Tomal (2010) said, “Action research is more concerned with improvement within the context of the study” (p. 14). In other words, action research is done by the practitioner, for the practitioner. Action research is cyclic, consisting of the following phases: (a) formulating emerging questions from one’s practices and from local and federal mandates; (b) devising new or modifying existing research questions; (c) teaching action to address research question; (d) collecting data; (e) interpreting data; and (f) assessing outcomes and modifying action plans or create a new action plan.

I believe that these different phases of action research provide many opportunities to create knowledge. Greenwood and Levin (1998) used the phrase “cogenerative learning” to describe the action research process. The generation of knowledge describes the role of teachers as “generators of knowledge rather than receivers and enactors of knowledge produced by outside experts” (Efron and Ravid, 2013, p.7). Because action research focuses on creating knowledge, it is important to adapt a framework that guides the creation of knowledge. In this study I used the Constructivist philosophy to provide this framework, since it is a philosophy of how one learns.

Constructivist Philosophy

Constructivism is actually a philosophy of how one learns. It is not an instructional delivery system (Pelech & Pieper, 2010). To apply the Constructivist philosophy, I translated the philosophy into general principles that describe the cognitive actions needed to implement the Constructivist philosophy. These principles come from the ideas of Piaget, Vygotsky, Dewey, and Bruner.

1. *The nature of knowledge.* Constructivists believe that knowledge is not passed on; rather, it is a subjective, autonomous construction. Appearing in different forms (modes) such as visual, musical, and logical, knowledge is a dynamic entity that continually modifies and monitors itself.
Key terms: autonomous, constructed, different forms, self-modifying
2. *How knowledge is organized.* Knowledge is organized into cognitive structures, referred to as *schemas*, which are organized representations of previous experiences. The parts of the structure have no meaning by themselves; rather, they are related to each other. The nature of a mental schema is determined by the relationship of the parts to each other, and its complexity.
Key terms: schema, relationship of parts to each other, complexity
3. *How knowledge comes into existence (general concepts).* Knowledge is created in the context of solving an authentic (everyday) problem; it is created through an external process and an internal process. Society and local situations put forth what knowledge is important and meaningful, while individuals create their own version of this knowledge. The process is focused on modifying previous knowledge or connecting previously disparate knowledge spaces.
Key terms: authentic problems, societal influence, personal modification of cognitive relationships
4. *How knowledge comes into existence (general processes).* Three major concepts are involved in the creation of knowledge: assimilation, disequilibrium, and accommodation. *Assimilation* is the process of using an existing mental structure to address a new situation. *Disequilibrium* is the condition in which the process of assimilation is either ineffective or inefficient. Disequilibrium occurs only when the learner's expectations of assimilation are not met; it is the level of the learner's understanding that mitigates disequilibrium. *Accommodation* is the process of modifying the cognitive structure in order to address a situation that was not effectively or efficiently addressed. This modification of the cognitive structure is the result of the parts having a new relationship between each other and/or the schema having a new organizing theme, which will result in more and effective student learning.
Key terms: assimilation, disequilibrium, expectations of the learner, accommodation, reorganization
5. *How knowledge comes into existence (specific cognitive actions).* Seven actions are identified here: (a) compare and contrast; (b) find patterns; (c) analyze and reorganize relationships (this includes creating new teaching activities, new core values, new

theories, and a new philosophy); (d) put in different modes; (e) hypothesize, predict, and evaluate; (f) summarize; and (g) look for disequilibrium, and apply previous actions.

Key terms: all of the above

Blending Constructivism with Action Research

Integrating these major Constructivist components into the action process cycle, I formulated prompts that I used as guides in knowledge making, thinking, and decision making. These are shown in Table 1.

Table 1

Constructivist-Based Prompts Used in Action Research

Emerging questions	Creating an initial action plan
1. Am I growing as a teacher or am I staying the same? (disequilibrium)	1. What is it that I am addressing? What is my research question? (authentic situations, hypothesize/create theory)
2. Are certain personal theories not working? Why? (disequilibrium, create theories)	2. Is it a new innovation or a modification of what I already do? (authentic situations, reorganize relationships)
3. Does the literature present strategies and theories that may result in transforming my teaching/addressing what is bothering me? (create theories, reorganize relationships)	3. What theories or ideas from the literature will I be using? Do they represent a new theory or philosophy? (hypothesize, reorganize ideas)
4. Are my core values being challenged? (disequilibrium, authentic situations)	4. What are my goals for implementing this plan and these strategies? How do they relate to my core values? Confirm them? Change them? (reorganize relationships, disequilibrium)
Data collection	Data interpretation

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- | | |
|--|--|
| <ol style="list-style-type: none"> 1. What type of data have I used in the past? Effective or not effective? (authentic situations, evaluate) 2. What types of artifacts will align with the transformation I am looking for? Why do these artifacts have meaning for me? (hypothesize, reorganize relationships, evaluate) 3. What types of artifacts and data align with my teaching philosophy? With any new theory, strategy? (hypothesize, predict) 4. What must I do to ensure that this research is trustworthy and has credibility? (authentic situations, predict/evaluate) | <ol style="list-style-type: none"> 1. How do I define, describe, and classify the data? (create patterns, classify) 2. How do patterns and themes relate to each other? Do they form a new philosophy or core values? How do the quantitative and qualitative data relate to each other? (create/reorganize relationships) 3. How can I use a different framework for analysis? How does literature align with this different framework? (create/reorganize relationships) 4. Reviewing my journal notes, field notes, student comments, etc., what levels of thinking are represented? (organize knowledge, levels of thinking) |
|--|--|
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Creating a new action plan

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1. Does the interpretation of data address the goals of the research? If not, what must be done? (authentic situations)
 2. Are there any conflicts between outcomes or different data forms? (disequilibrium)
 3. What type of teaching strategies will address this disequilibrium? (disequilibrium, create theories)
 4. Do any of the teaching strategies in the new action plan require new theories? If so, how does this influence previous strategies and my core values? (create theories/practices)
 5. For the new teaching strategy, what am I discarding? What new materials do I need? (authentic situations)
 6. How does the new plan align with literature? Align with school, state, federal guidelines? (authentic situations)
 7. In what ways does the next cycle transform my teaching? Is it a transformation or just a change? (reorganize relationships)
 8. What are the helping or hindering forces for implementing the action plan? (authentic situations, analyze relationships, disequilibrium)
-

Data Gathering

Based on the methodology detailed above, I selected the student participants and began gathering the data.

Participants

Participants were undergraduate students enrolled in an education assessment course. They were either majoring in elementary education or minoring in secondary education. Participation was voluntary; if students wished not to participate, they could withdraw at any time and their grade would not be affected.

Mixed-Methods Approach

This study utilized a mixed-methods approach, using both quantitative and qualitative data. The quantitative data came from student ratings on the Likert scale of the survey (discussed below), and the qualitative data came from student explanations on the survey, informal discussions with students, members check (an in-class discussion with students concerning the project and/or results), individual student interviews, and instructor field/journal notes. According to Johnson and Onwuegbuzie (2004), “The goal of mixed methods research is not to replace either of these approaches but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies” (p. 14-15). In general, the quantitative data describe “the what,” while the qualitative data describe “the why” or “why this is meaningful or important to me.”

Procedure

Students were provided a reading list that contained a citation for an article that could be electronically accessed, and also contained questions for the prelecture quiz administered in class. The quizzes were done in class, usually at the beginning. The quizzes were designed to activate the basic knowledge of terms and concepts that were then to be used during class discussions. Figure 1 provides an example from the reading list.

After several quizzes, students were given a survey, asking them to rate how the platform influenced their thinking and their participation in class discussions. (Note: The original survey contained a question that was eventually deemed as unnecessary for this project). A six-point scale was used because I did not want to provide students an opportunity to “play it safe”; that is, I did not want students to pick a score in the middle, but I wanted students to make a clear and concise decision on the effectiveness.

Article: Sternberg, R. J. (2007/2008). Assessing what matters. *Educational Leadership*, 65(4), 20-26.

According to the author, what is the one skill that he did NOT need to succeed in his field?

1. According to the article, what should we (teachers) assess?
2. The article uses a model for assessment, called WICS. What are the components of this model?
3. According to the author, what is the most important, but most neglected aspect of education?
4. According to the article, traditional assessments provide little help with what?

Figure 1. Excerpt from the reading list used for in-class quizzes.

Findings and Discussion

This section presents the findings, and analysis and discussion of those findings. The section is divided into two subsections, based on the two phases of the study.

Phase 1

The first phase of this study focused on the traditional closed-notes quiz, with the intent to learn about the effectiveness of this traditional instrument. Table 2 displays the results from the Likert scale; a score of “1” is the lowest possible score, and a “6” is the highest possible score.

Table 2

Phase 1 Survey Results

Likert rating	1	2	3	4	5	6
Number of student responses	0	1	0	3	4	0

The results indicate that students did believe that closed notes helped them think, but this perception was not overwhelming because there were no responses of a “6.” The data for the second question of the survey, whether the closed-notes quizzes helped with class discussion, is shown in Table 3.

Table 3

Student Ratings for the Effectiveness of Closed-Notes Quizzes on Remembering Information Effectively

Likert rating	1	2	3	4	5	6
Number of student responses	0	0	1	2	5	0

The data indicates that students believed that the closed-notes format was effective for preparing them for the class discussion, but like the data for thinking, this was not overwhelming, and there was a score of a “3.” Using the Constructivist theme of creating connections or relationships, I examined any possible relationships between the data of both questions. Table 4 displays this data.

The table indicates that the overall ratings had roughly the same results for both questions; however, it is important to analyze this further. Question 2 had more ratings of “5” but also a score of a “3.” In comparing responses to both questions, it can be seen that both questions had the same rating three times, and Question 2 (effectiveness for class discussion) had a higher rating on three occasions.

Table 4

Comparing Ratings for Effectiveness of Remembering with Effectiveness of Class Discussion

Student	Effectiveness for thinking (Question 1)	Effectiveness for class discussion (Question 2)
1	5	4
2	5	5
3	4	5
4	5	5
5	5	5
6	4	3
7	4	5
8	2	4

Overall, students believed that the closed-notes format was somewhat effective for promoting thinking and class discussions. While the data indicated that closed-notes quizzes were equally effective, the ratings from Student 8 represent disequilibrium. To provide a deeper understanding of students’ schema of quiz platforms, I decided to analyze their comments from surveys, class discussions (members check), and formal and informal discussions. For this phase, five students were interviewed. Table 5 displays the coding of student comments from all scenarios.

Table 5

Student Comments Concerning Closed-Notes Quizzes: Phase 1

Quiz preparation for closed-notes quizzes	
Memorization	Writing down the answers
Typically, I do memorize	I write down the answers
Make that little graphical organizer	Write it out a couple of times
	Write directly on packet or book...I don't use a notebook

Having to recall knowledge helps memorization [better] than having it in front of you

I had to memorize the text to do well

I had to read and memorize the answers so I knew what we were going to talk about during the discussion

I try to memorize where it is, what the answer is

Could be better ways but it did help me be able to memorize the question and answer

Quizzes as providing prior knowledge (guided questions from the reading list)

The guided questions along with (discussions)

The answers are usually direct...pertain to the day's lesson that helps actually have a class discussion

What helped me [is] we had specific questions to look at...but I had specific questions to look for, that made it easier for me

Quizzes as part of a larger system (quizzes and other instruments)

I would give a chance, five minutes out of a quiz (implies for open notes)...I wouldn't give open notes the entire class

We can use quizzes to test basic knowledge or maybe using quizzes for [basic] knowledge or maybe using quizzes at the beginning

Use little quizzes to accommodate a bigger quiz

The conversations within very helpful and it makes me learn the material more

Open up and expand our ideas

Something that is not a quiz

(Open notes help?) Oh yea

(Reflection would be effective)

Quizzes as a motivating tool

Make people want to learn

I'll do better in your class because it's my major

This [quiz] forces us to read some nice quality research

To get a good grade

Active processing/how one learns

Quizzes and learning

Applying the quiz

Projects, applying that knowledge

If we have the quiz, we have that prior knowledge

Help me remember the quizzes, help me retain that information

When you add something personal, it stays in your long-term memory

Quiz was multiple choice; it helped me recall the information better

Disadvantages of a closed-notes quiz

(Does memorization help with long-term memory?) No

I forget the information right after the quizzes are done and I forget the right words to explain from the test

Just very tedious

I can memorize a definition, but I won't know what the word means...

It is easy to go find the answer, you actually don't have to read, grade-wise it helps us

Sometimes I remember exactly where the answer is in the reading, but not the final answer

It depends...if it's something I feel I need to know, I will remember it longer

To explore further, either through more connections or through disequilibrium, I examined my field notes, which came from my observations and conversations with students. Table 6 contains a sample of these notes.

Table 6

Field Notes for Phase 1

Quiz Preparation	Quiz Format
Memorization	Two articles (for quiz) made it difficult to learn

Informal conversation (they took notes, wrote them out)	One reading, easier to get in-depth, go through multiple times
More memorization	[They] liked guided reading

The qualitative data enabled me to create a schema for explaining student perceptions of closed-notes quizzes. This schema indicated that students were thinking of quizzes as possible thinking tools, but this schema was neither fully developed nor cohesive. The following paragraphs describe the schema.

1. Students perceived quizzing as a tool for accountability and motivation, but it was not clear whether this motivation was just for obtaining good grades or for enabling creation of a meaningful experience. No mention was made of closed-notes quizzes as providing real meaning for students.
2. Closed-notes quizzing was considered to be a part of a larger system, as it activated or created needed knowledge for discussions, and these discussions, in turn, expanded the initial knowledge. Additionally, closed-notes quizzes could be used as a compliment to larger quizzes (exams) or for activating basic knowledge.
3. Student comments indicated that they perceived closed-notes quizzes as aligning with the Constructivist philosophy of using prior knowledge as the starting point of the learning process.

The theme of active processing emerged throughout this phase; phrases such as “applying knowledge,” “projects,” and “adding something personal results in that knowledge staying in long-term memory” refer to an active processing activity. However, it appeared that closed-notes quizzes were not part of this process; there were comments of the knowledge gained from closed-notes quizzes *not* staying in long-term memory, and that a person did not have to actually read the article. Additionally, no specific comments were made about active processing and closed-notes quizzes. Student comments and my own field notes indicated that students assimilated to the situation by writing out notes in preparation for the quizzes. No specific references were made to active processing with regard to closed-notes quizzes, although there was an indication of this—the reference to guided reading (each reading had questions that students had to answer) implied that students were using the questions as prior knowledge and were actively reading to find and connect to this question.

Phase 2

To guide the second phase of my study, I used the Constructivist principles of fully activating prior knowledge and addressing disequilibrium. The action plan for this phase consisted of three objectives.

1. Continue the overall goal of exploring student perception of the effectiveness of quiz platforms; in this cycle, that would mean open-notes quizzes.
 2. Build on the present schema of applying knowledge by creating projects. While the schema from the first phase had incorporated this construct, I intended to develop it
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more fully; as Leinhardt (1992) said, “The impact of prior knowledge is not a matter of ‘readiness,’ component skills, or exhaustiveness; it is an issue of depth, interconnectedness, and access” (p. 22). This would be done through the open-notes platform in which students would use notes *that they created* (as opposed to using their books) to apply knowledge to create authentic products. Implementing open-notes quizzes in this manner would enable students to fully activate the schema of using these quizzes to apply and create.

3. Address the disequilibrium of students not perceiving closed-notes quizzes as promoting active processing. This would be done by fully activating the construct of active processing and then by creating the environment in which students would connect the construct of active processing to quiz preparation for closed-notes quizzes.

Open-notes quizzes were given during this phase. These quizzes, like the quizzes of Phase 1, took their questions from the reading list. Students were to use any method of creating notes to answer these questions, and were to bring these notes to class. Quiz questions required students to use their self-constructed notes to create an authentic problem. This practice aligned with student comments of applying knowledge or creating projects. One quiz required students to create a newspaper article summarizing the main points of the reading. Another quiz, which was on a reading focusing on the factors influencing the retention of college students, asked students to write a formal letter to the college president concerning his retention plan; students were expected to use information from the reading in their letter. A third quiz, whose reading focused on the effect of a computerized platform on student test performance, expected students to use the information from the reading to design a key chain or pencil holder to be given to parents and which contained information from the reading.

Students in this phase were asked to complete surveys containing one requirement: ranking which format (open- or closed-notes) was more effective for learning. Additionally, students were asked to explain their choice. Six students were interviewed for this cycle, with two students being interviewed for the first time, three students who were also interviewed for the first cycle, and one student who was interviewed twice during this cycle. The reason for some students being interviewed more than once was that I wished to gain more information concerning student views on closed-notes quizzes and active processing. Comments from reflections, informal discussions, members share, interviews, and surveys are shown in Table 7.

Table 7

Student Responses Concerning Open-Notes Quizzes

	Open-note quizzes	Closed-note quizzes
Quizzes and active processing	To apply the knowledge Makes you think deeper and pay attention to details	Yes (when asked in active processing would work with closed-notes quizzes) It would be good...I still like the open-notes

I had to apply what I read in the text to an active activity	because we have the information there
Forces you to pick out important things	It's possible with more time (when asked if active processing can be used with closed notes)
You have to explain so someone will understand it	[Yes], but it won't be as detailed
Makes me take more detailed notes	You can prepare students for those closed-notes [quizzes] by doing those exercises [active processing]
Organized it chronologically (when taking notes on the article)	
So it made sense...not all over the place	[Hand in the created notes] If created notes like the graphic organizer...catch them doing something good
It made you connect	
Organize into certain thoughts	[It's effective] if we use it in another subject
	The creative thing, can be used for closed-notes

Quizzes and assessments

- There is more of a personal growth you can assess
- You get what the person is thinking
- It allows you to catch [students] doing something good
- Will help show their connections

Retention

It's much better for retaining if we're using it in another subject

We have the information there

Allowed me to look back at my notes...yea that's what it is

Active processing and creativity

It was better for creativity because you used the integrated curriculum

Gives us time to be more creative

We design something, create something

Disadvantages

It won't be as detailed because we don't have all the notes there in front of us, we're forgetting some details we want to write about

Instead of memorizing for the quiz

With closed-notes you don't have that safety [of going back and immediately think, OK, yea, that's what it is]

We have to memorize everything

Table 7 indicates that students have developed a much more complicated and complex thinking scheme regarding the different types of quiz platforms. Implementing the Constructivist practice of using different modes, I created a depiction of this new schema (Figure 2).

As the figure illustrates, the schema has been transformed dramatically. The theme of active processing emerged as the organizing theme, subsuming quiz platforms. In this new schema, active processing has been described in terms of concrete behaviors, and the purposes and uses of active processing have been expanded to include not only quiz platforms, but also as an instrument for delivering the integrated curriculum and for assessing student growth. Additionally, all the components of the schema are related to each other; this schema presents active processing as being the driving force behind assessment and curriculum. In terms of the research questions, either quiz platform would be effective, as long as the quiz preparation or the quiz itself involved active processing. Using this schema would enable me to transform my delivery system into one which is driven by different components of active processing.

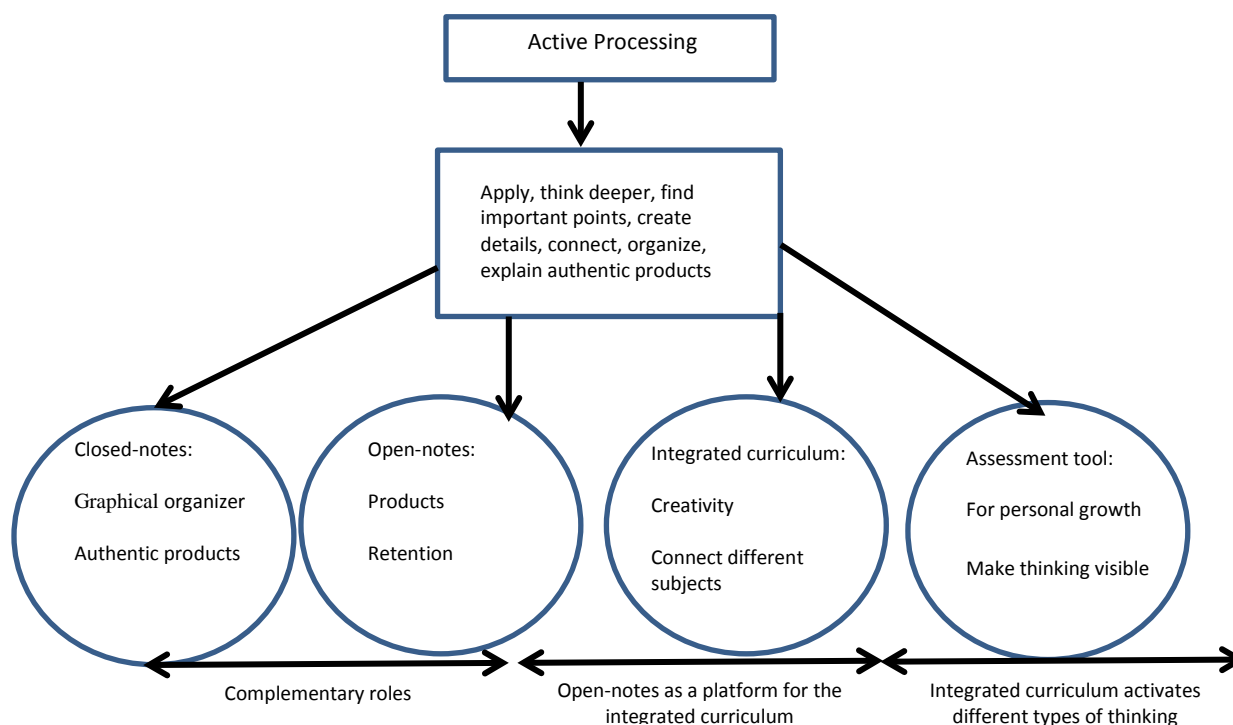


Figure 2. Graphical representation of the new schema.

Limitations and Suggestions for Future Research

While this research proved effective in improving student learning, several limitations should be noted. First, the size of the class limited the possible number of different perspectives that could be generated and analyzed. Although I do not advocate that the students be forced to participate in such a study, having a larger group to compare quantitative data would certainly be useful.

Another limitation resulted from the logistical requirements of conducting the research in the everyday context of the classroom—I simply did not have enough time to conduct personal interviews of all students for both cycles. While I attempted to compensate for this limitation through surveys, members check, and informal conversations for both cycles, future researchers may well want to set aside more time, whether in class or after school.

A third limitation was that while students did construct the concept of active processing in preparation for closed notes, little mention was made of the active processing construct during the actual closed-notes quiz. This might be corrected by having the quiz questions focus less on factual information and include questions focusing on issues or problems raised by the readings and their application to today's issues.

Conclusions and Reflections

The Constructivist philosophy proved effective in guiding this action research project. By applying Constructivist principles such as classifying, looking for disequilibrium, connecting previously disparate data to each other, and/or creating a framework for this connection, I was able to *create*—along with my students—a *new knowledge schema* regarding quizzes and learning. The new schema represented a transformation as the purposes and relationships of quizzing and learning were reorganized. It included the following changes to the course curriculum for the following semester: (a) the course started with an assignment on the concept of active processing; (b) students utilized active processing for all class activities, including preparation for closed-notes quizzes, and all discussions on assessment tools were guided by the concept of active processing; and (c) as an end-of-semester activity, students were required to create a booklet containing active processing activities they used during the semester, and this included preparing for quizzes.

I emphasize here that this process involves a kind of *collaboration* between teacher and students. Far more than simply asking students their opinions about the quizzes and discussions, the teacher needs to be willing to observe his or her individual reactions and to adjust—and readjust—the curriculum as needed. It is an iterative process for which patience is also needed.

I also emphasize that while the mere creation of a new schema is exciting, the purpose of action research is to improve student learning and teaching. Only through the *implementation* of the new knowledge schema developed in a project can a teacher determine whether the theory actually improves student thinking and learning. The action research cycle is not complete until the new knowledge has been implemented. In this project I did not have enough time to implement the new schema during the semester. This can be frustrating, especially if the students change each semester or the teacher is assigned a different class topic. Fortunately, I was able to implement the schema in the next semester and to test its efficacy with the same students and similar material.

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