Chapter 6
Engaging Adolescent Students' Metacognition Through WebQuests: A Case Study of Embedded Metacognition

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Abstract This chapter is a case study which examines how graduate teacher-education students designed WebQuests (WQs) that engaged their students metacognitively through embedded activities. As a course requirement, students created their own WQs for their adolescent students after having engaged in one and learning about metacognition from both the perspectives of a teacher and a student. The results showed various types of metacognition were embedded at both the junior high (JH) and high school (HS) levels. Both executive management metacognition (EMM) and strategic knowledge metacognition (SKM) were embedded at both school levels. In addition to individual metacognition, metacognitive activities were embedded in a social context, involving pair and group assignments. Sometimes metacognition was required, while other times it was expected. Metacognition was embedded in several WQ components, especially tasks, process, evaluation and conclusions. Conclusion-component metacognitive embeds were generally expected but not required, while metacognitive embeds in the tasks, process and evaluation components were more often required. Affective self-reflections (ASRs) were also embedded in the WQs at both school levels. Implications for future research and designing WQs to maximize metacognitive engagement are discussed.

Keywords Metacognition · E-learning and teaching · Affect · Scaffolding · Social interactions · Multimedia

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A. Peña-Ayala (ed.), *Metacognition: Fundaments, Applications, and Trends*,
Intelligent Systems Reference Library 76, DOI 10.1007/978-3-319-11062-2_6

Abbreviations

A	Let's learn about the smallest thing in the earth (Atom)
AF	If you don't become an actor you'll never be a factor
ASR	Affective self-reflection
BC	Building character: preparing for role
CD	Show me your neighborhood: A quest for cultural diversity
DC	Demystifying the cell
EbM	Embedded metacognition
EMM	Executive management metacognition
F	Life before the rocks: A theatrical journey to Grosse-Ile (Famine)
GM	As Mt. Olympus turns: Greek mythology, a soap opera
GG	Let's get the groove going!
HS	High school
JH	Junior high
M	Machinima: What is it, why you might care and how can it help you in your English lit and theater classes
MLK and MX	Martin Luther King and Malcolm X have something to say to you!
N	Lessons of Nanook from yesterday to today
Nu	Number systems: Does 11 = 11, 3 or 17?
PWQ	Piaget WebQuest
RT	Right triangles are your friends!
S	Cut it out: printmaking with stencils
SCW	Viva la revolucion: Spanish civil war and better understand the house of Bernarda Alda
SM	Social metacognition
SKM	Strategic knowledge metacognition
WBS	White school—black school: Melba Patillo, integration and the Little Rock 9
WQ/WQs	WebQuest/WebQuests
WS	Writing to show—not tell
WW	Why write?

6.1 Introduction

Since their inception, WQs have been recognized as tools for stimulating students' metacognition, but there has been little research on the topic. For approximately 20 years now, both metacognition and WQs have emerged as topics with important educational implications. This chapter is a case study that focuses on the questions: how did graduate teacher-education students, many of whom were already teachers, design WQs for their students in ways that would engage them metacognitively, to what extent was metacognition embedded in their WQs; what kinds of metacognition were embedded, where, and how?

6.1.1 WebQuests and Metacognition

Dodge [1], developer of the WQ, characterizes it as an inquiry-oriented set of learning activities organized around use of the Internet. Dodge distinguishes between short and long term WQs. Short-term WQs emphasize the goals of acquiring and integrating a considerable amount of material, and the activities last from one to three class periods. Long-term WQs emphasize the goals of deeply analyzing information, and using it to create a product that demonstrates the learner's comprehension of the material. In order to create this product, the learner must transform or reconstruct information in a meaningful way. Activities in a long-term WQ extend from a week to a month. The WQs addressed in this chapter are all long-term.

According to Dodge, WQs have six critical attributes: (1) introduction, provides background information and sets the stage for the learning activities; (2) task, involves activities that are achievable and interesting; (3) information, learners are required to use various resources in order to complete the tasks; (4) process, a series of steps guiding students so they can accomplish the task; (5) guidance, information on how to organize the information acquired; (6) conclusion, to remind students of what they learned and encourage them to extend their learning. The WQs discussed in this chapter all have these attributes because they are embodied in the required Zunal WebQuest template.

Effective WQs are scaffolded structures that use the Web to help learners engage in an authentic learning experience where they transform what they learn into a deeper understanding and reflect on their metacognitive processes [2]. Thus WQs are natural environments for embedding metacognitive activities and developing metacognitive knowledge and skills.

In a review of research on WQs, Abbit and Ophus [3] found that while they may have a positive impact on learner attitudes and collaborative working skills, they do not offer substantial advantages over other instructional approaches for improving student achievement. However, use of WQs for improving student achievement has been found in several subjects. A study in Saudi Arabia [4] found a WQ to be effective for improving the reading comprehension of EFL students compared to control students who did not engage in a WQ, however, they noted, both students and teachers should be trained to maximize the effectiveness of WQs. Teachers need to know how to guide students through WQs in order for them to be effective. A study of WQ use in social studies classrooms in the U.S.A. found them to be more effective than traditional textbook-based classes [5]. The National Council of Teachers of Mathematics (NCTM) in the U.S.A. recommends WQs as tools for teaching topics such as the Fibonacci sequence, because when well-designed, they help students actively engage in the learning process, gather and analyze relevant information, and use higher-order thinking skills [6]. The key to successful WQ use appears to be the quality of their design and the ability of teachers and students to use them effectively.

Metacognition is commonly characterized as awareness and control over one's own thinking processes, knowledge and products, or thinking about one's own thinking. It is often conceptualized with reference to two major types: executive management metacognition (EMM) and strategic knowledge metacognition (SKM) [7]. EMM includes planning, monitoring, evaluating and revising while SKM includes declarative, contextual and procedural knowledge. Research suggests that while some people develop metacognitive knowledge and skills spontaneously, others need direct assistance in developing and using metacognition [8]. Research has documented the positive relationship between metacognition and academic performance [9].

A study of embedded metacognitive strategy training [10] found that students in Turkey who had metacognitive strategy training embedded in their English listening texts performed better on a listening test than control students who did not have embedded metacognition (EbM). However, EbM does not always lead to increased academic success.

Research comparing the combination of cooperative learning with EbM to cooperative learning alone and to traditional instruction in biology with high school (HS) students in Germany found that students who engaged in cooperative learning outperformed students on measures of socioscience decision making compared to those who did not, but there was no significant difference between students who also had EbM in their lessons [11].

Developing students metacognitively can be done through traditional instruction [7] as well as through computer-based learning environments. Azevedo [12], argued for a new paradigm in which computers are used as tools for promoting metacognition, which he viewed as especially important because of the pervasiveness of their use both in and out of school for learning about conceptually rich domains.

Poitras et al. [13] created the MetaHistoReasoning Tool to enhance metacognition when learning history. Students who used metacognitive tools built into this computer-based learning environment had better comprehension, memory, and reasoning about history when engaged in inquiries into historical events than students who did not use these tools.

A comparable study was conducted on teaching biology through use of a web-based tool, Young Researcher, which had prompts for guided reflection built into biology learning experiences. Guided reflection enhanced students' science inquiry skills and their ability to reflect on their own learning [14].

Cho et al. [15] developed a computer-based writing environment, Scaffolded Writing and Revision in the Disciplines, to provide support for students monitoring their own writing. They found that undergraduate and graduate students in the U.S.A. who used this system and improved their self-monitoring skills, also improved their writing more than students who did not develop the self-monitoring skills.

Research on EbM in a problem-solving learning environment for engineering students in Mexico to learn how to solve workplace problems, showed that EbM increased students' metacognitive awareness, helped them solve problems more successfully and earn better grades [16].

The concept of metacognition has evolved from self-regulation to include social metacognition (SM), where students engage in co-regulation [17–21]. Iiskala et al. [17] found that students working collaboratively to solve mathematical problems engaged in "socially-shared metacognition" in which awareness and control over thinking occurred between individuals—not just within them.

Although the concept of SM is relatively new in the literature, pair metacognition has flown beneath the radar for years in the context of pedagogical methods such as Pair Problem Solving [22], Guided Reciprocal Peer Questioning [23] and Think-Pair-Share [24], all of which entail SM in a partner setting. As with pair metacognition, group metacognition has also flown under the radar via use of cooperative learning methods such as Group Investigation [25] and Problem-Based Learning [26]. All of these pair and group teaching methods involve students engaging in SM, although it is usually not discussed explicitly. As Chan [18] noted, there has been little research on how students collaborate and co-regulate in computer-supported learning. A special issue of the journal Metacognition and Learning focused on co-regulation in computer-supported collaborative learning.

Included was a study on task regulation and team regulation by HS students using a computer simulation [27]. Task regulation emphasized comprehension monitoring to ensure students understood the task. Team regulation emphasized how they worked together in order to perform the task successfully. They found that co-regulation, including group planning and monitoring, predicts group performance, so it is important in collaborative inquiry. Computer-supported inquiry, where students work collaboratively on shared tasks, is a common feature of WQs. Another article in that special issue, which also examined adolescents, found that co-regulation on a computer-based historical inquiry task has a positive relationship to group learning outcomes [28].

Affective Self-Regulation. Self-reflections are more than metacognitive activities and should be defined more broadly to include affective self-reflections (ASRs) as well. The affective domain focuses on feelings and includes emotions, attitudes, values and motivation. Affective self-regulation has been described as "meta-affective reflections" and emotional regulation by Chick et al. [29]. It includes sensitivity to one's feelings (awareness) and managing them (control). So awareness and control are the key features of both cognitive and affective self-regulation.

A manifesto on affective learning from the MIT Media Lab made this type of point quite emphatically, especially when dealing with learning in the context of digital technology [30]. Bandura et al. [31] found that adolescents' perceived affective self-regulation efficacy, including regulation of both positive and negative emotions, had an impact in psychosocial situations and was accompanied by regulation of academic and pro-social behavior. A book addressing the importance of affective self-regulation in a wide variety of social situations conceptualizes motivation as a separate, but most important dimension of self-regulation [32].

Considerably earlier, The BACEIS Model of Improving Thinking [33] posited that cognition and affect comprise two separate but interacting subsystems. Awareness and control of one's own thinking is described as metacognition, whereas awareness and control of one's own feelings is described as affective self-regulation (Fig. 6.1). Both must be considered, along with their interactions with each other and with the academic and nonacademic environments, to best enhance intellectual performance. Affective self-regulation includes management of one's own attitudes, values, emotions and motivations.

For example, regulating one's motivation to learn to read can influence one's willingness to use cognitive and metacognitive reading strategies when reading challenging text in the classroom and outside of school, while doing homework.

Thus the BACEIS model is intended to help develop students both cognitively and affectively so that they become independent, self-directed learners who can apply what they learn, as represented in Fig. 6.2 (read clockwise from the top).

A more recent approach to fostering active, meaningful learning, the construction-deconstruction-connectionist process, has much in common with the BACEIS Model. The process approach assumes that classroom learning is a cognitive, psychodynamic and social process [34] and identifies four different metacognitive domains in classroom learning: the self, the professor, classmates and the environment.

A study by Pang and Ross [35] testing this model with college students in Texas, studying criminal justice and British literature, used a four-step process with students who worked in groups and engaged in EbM activities in these two subjects. The results showed that the approach facilitated comprehension of complex constructs, improved students' satisfaction and effectiveness.

Metacognition and WebQuests. There is little literature on the design of WQs or the actual use of metacognition in WQs. Existing studies are primarily about language learning. Work on English for Specific Purposes in Spain [36, 37] which emphasizes use of English for professional and academic contexts, presents goals and guidelines for developing students' metacognition through WQs so they can be autonomous, life-long learners, communicate effectively and develop new literacies for constructing meaning. The English for Specific Purposes WQ includes attention to SKM: declarative—having background knowledge of the discipline, contextual-assessing the specific situation so they can respond appropriately and procedural-knowing how to use a variety of resources to solve problems and answer questions. The ESP WQ also attends to EMM: planning—developing genre awareness, so that they can plan to make specific language choices in order to achieve specific communication goals; monitoring—getting corrective feedback on drafts; and evaluating—reflecting on their learning processes and assessing their progress.

Another study involved a WQ designed to enhance use of EMM strategies for improving oral English skills [38]. College students in China were required to create WQs on the metacognitive strategies of self-planning, self-monitoring and self-evaluating. Each group of students focused on one of the three strategies. Then students shared their WQs. To assess students' reactions, questionnaires were administered and students were interviewed.

The results show that students' attitudes toward oral English and learning through WQ were enhanced by this experience. They also indicate that the WQs

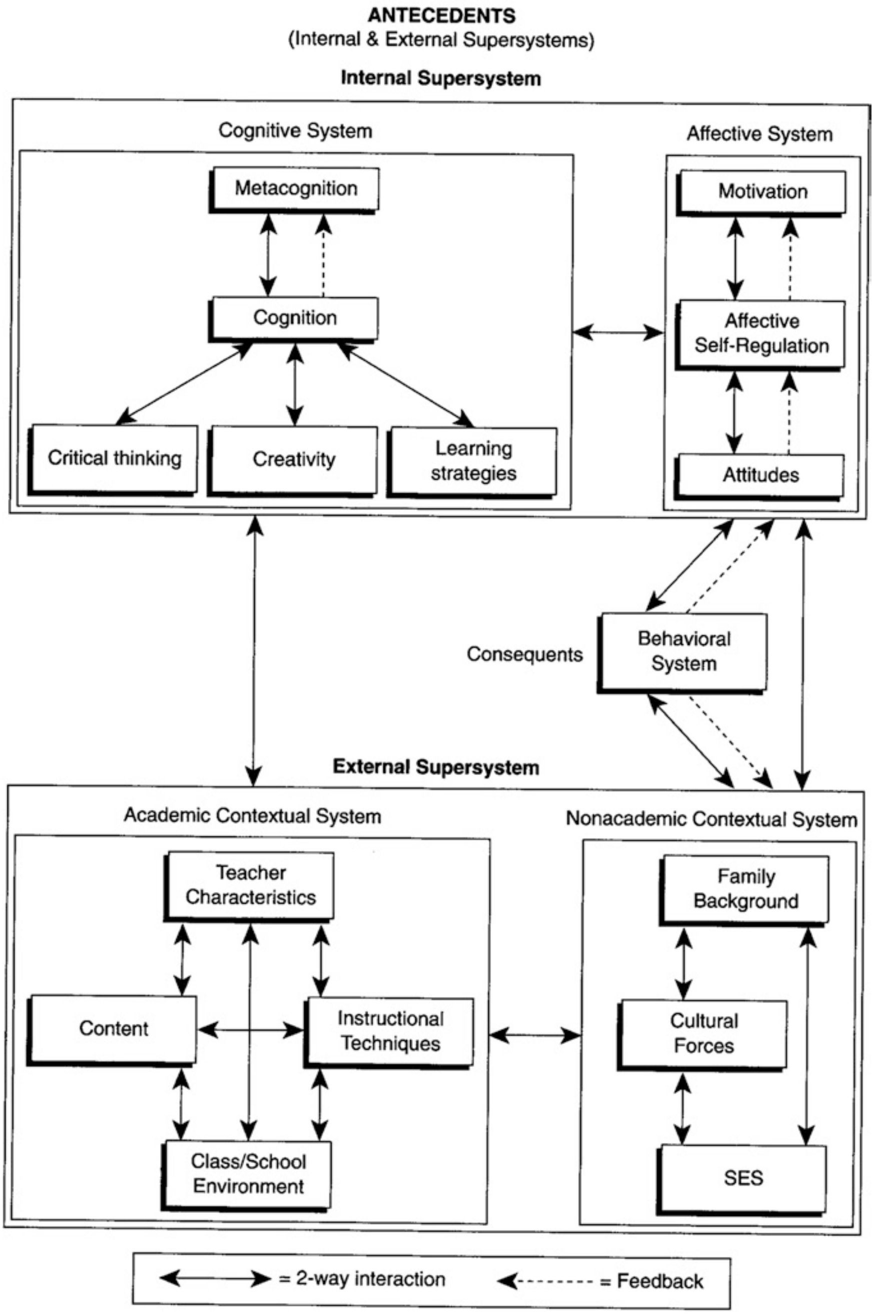

Fig. 6.1 BACEIS model of improving thinking [33]

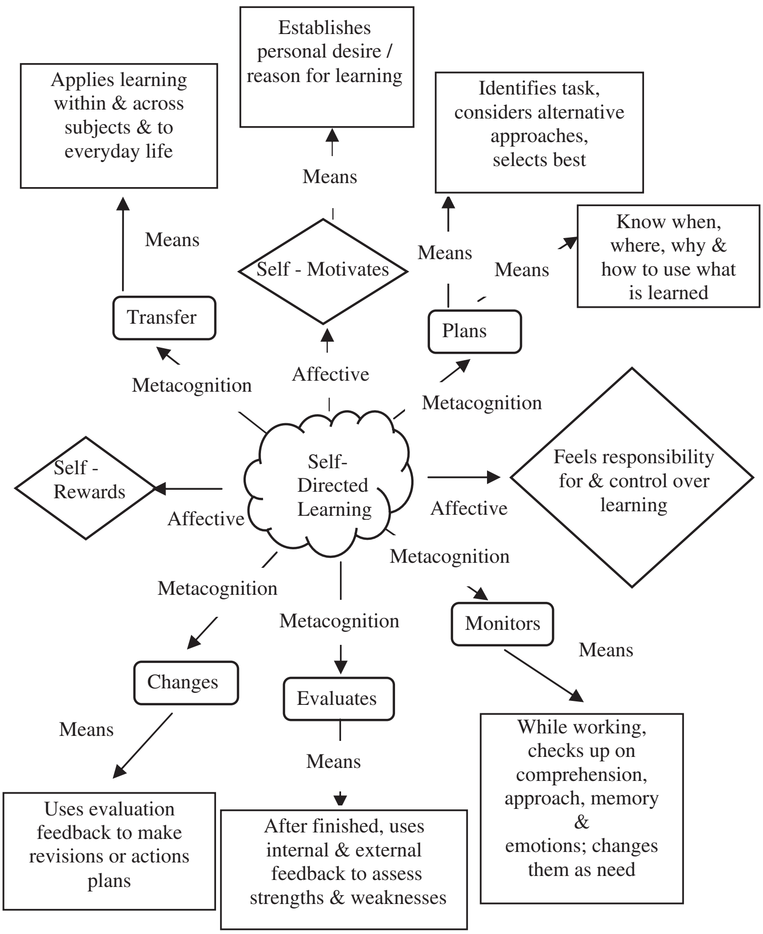

Fig. 6.2 Self-directed learning

improved students' use of metacognitive strategies for speaking English. A similar study on teaching writing in China and found that strategy training for writing English was needed and that WQs improved students' use of EMM metacognitive strategies for writing English [39].

A study of teacher education students in Colombia using WQs for learning English as a Second Language showed WQs to be effective forms of curricula for changing students' views of themselves as learners and future teachers [40]. An exception to this pattern of WQs and metacognition in language learning occurred at an elementary school in Taiwan [41]. Their focus was on using a WQ to learn the science topic of environmental protection soap.

Qualitative and quantitative analyses showed the WQs were effective in helping 6th grade students in the experimental group, where scaffolds built into the WQ assisted students in goal setting, strategic planning, monitoring and self-evaluating, when performing WQ tasks.

Students in the control group, who did not have metacognition scaffolds embedded in the WQs, did not engage in these self-regulatory processes.

Elsewhere [42] I have described rather extensively the teaching metacognition involved in the design and implementation of my Piaget WebQuest: Uncovering and Discovering Piaget [43], which was required of all of the undergraduate and graduate teacher education students in my educational psychology courses. It also describes my teaching metacognition in the follow-up assignment in which students created their individual WQs, and my students' metacognition in these two assignments.

6.1.2 Theoretical Framework

The approach uses a synthesis of several theoretical frameworks, including information processing, constructivism, and situated learning as described in Hartman, 2012 [42]. Mayer's Multimedia Learning Theory [44], an information processing theory, is based on three assumptions: two channels for processing multimedia information are visual and auditory, people have limited capacity for processing information, and our processing system is active. To design effective multimedia tools, such as WQs, which usually involve verbal, pictorial, and auditory processing, these principles must be taken into consideration, as should metacognition and affective variables such as motivation. Metacognition is considered the highest level of thinking in information processing theory [33, 45].

Distributed Learning theory, which focuses on emerging technologies and their use in education [46], posits that new types of communications are needed for conveying content, and advocates using new media as an alternative to the "teaching by telling" approach that has dominated education. WQs were developed around the same time that Dede first proposed Distributed Learning theory, which emphasizes learner control, interactive technologies, and learning-by-doing, all of which typify WQs.

Cognitive constructivism underlies students' experiences as they engage in the learner-centered, inquiry-oriented PWQ, and use what they learn to co-create educational products, instructional activity designs, that require application of the acquired knowledge and skills. The individual, student-created WQ itself is consistent with social constructivist theory, because it is considered a cultural artifact, which Vygotsky [47] depicts as tools, objects, concepts that connect individuals to society and society to individuals. Social constructivism also underlies the scaffolding process of students first engaging in a collaborative, structured WQ experience (PWQ) before creating their own WQ, the scaffolding they received while creating their WQs, as well as the scaffolding they provide for their students while engaging in their WQs.

Situated learning theory is a framework that guides this work. Brown et al. [48] and Lave and Wenger [49] emphasize the importance of the context in which learning activities take place. They argue that learning is situated in and a product of the activity of the learner in the context in which learning occurs. In this case, teacher education students participated in activities which are implemented by members of the educational community: finding, selecting and using a variety of educational resources to create authentic educational products they can use in the real world of their own classrooms with their own students. As members of a community of practice, there was extensive social interaction among them as they developed and shared their WQs.

The second of three parts of the teacher knowledge and learning framework [50], "knowledge-in-practice", depicts this approach in terms of teachers' knowledge about and use of metacognition in their own and their students' practices, as well as the design of learning experiences. This chapter is a case study of metacognitive activities embedded in the WQs designed for adolescents in junior high (JH) schools and high schools (HS). The creation of WQs was a requirement in the course. Major questions posed are: To what extent were WQs embedded with metacognitive activities? What kinds of metacognitive activities were embedded, where and how?

6.2 Method

6.2.1 Participants

Participants were graduate teacher education students enrolled in Adolescent Learning and Development at The City College of New York, a large, urban college in New York City in the Northeastern U.S.A. during Spring, 2011. The 24 students were born in 8 countries: Belgium, Ghana, Haiti, Hong Kong, Jamaica, Taiwan, Turkey and the USA. There were 12 females and 12 males, some of whom were already teachers while others were preparing to be teachers.

Students were allowed to decide whether or not to publish their WQs, and publication was not considered in their course grade. Eighteen of these students still had published WQs as of January 2014. It is these 18 WQs (75 % of the class) that are analyzed in this chapter (Table 6.1).

Eight of these WQs were developed by males (44 %) and 10 by females (56 %). 67 % of the JHWQs were developed by males and 33 % females; at the HS level, 33 % were developed by males and 67 % by females.

6.2.2 Metacognitive Engagement Preparation

Learning about and engaging in metacognition began the first day of class and occurred regularly throughout the course. While teaching I systematically use and explicitly highlight my metacognition to help my students become more aware of what it is (declarative knowledge); why it is important for thinking, learning

Table 6.1 Overview of student-created WebQuests by school level

Level	Title	Subject(s)	URL*
JH	S	Art	88723
JH	AF	Life skills/Careers	93523
JH	GG	Music	90065
JH	A	Science	92839
JH	F	Life skills/Careers	88981
JH	Nu	Mathematics	89904
HS	GM	Social studies	92253
HS	BC	Art/Music	89276
HS	DC	Science	88708
HS	N	Art/Music/Social studies	93333
HS	M	English lit, theater, technology	92968
HS	MLK and MX	Social studies	93527
HS	RT	Mathematics	88992
HS	CD	Art, music	89013
HS	SCW	English, language arts, history	89650
HS	WBS	English, language arts, history	93343
HS	WW	English, language arts	88986
HS	WS	English, language arts	90917

* All begin with http://zunal.com/webquest.php?w

and teaching; when to apply it (contextual knowledge); and how they can assume greater control over their own metacognition, and apply strategies for fostering metacognition in their own students (procedural knowledge).

By explicating the use of metacognition in my own PWQ development, implementation, evaluation and revision, students were provided with a model framework for constructing their own WQs using their own metacognition and embedding it in their WQs for their students.

Metacognition was one of the main topics covered in this course, and it was a theme carried throughout the semester—both enhancing students' metacognition and teaching metacognitively. Metacognition was included in the course textbook and many resources, some required and others optional, were provided at the course's Google website, "Adolescent Learning and Development", and there were many class activities involving metacognition and discussions about it. By engaging in the PWQ, students saw how I embedded and they experienced EbM activities in several components (Table 6.2):

Introduction. Activated prior knowledge through a series of questions regarding what they already knew about Piaget and Constructivism and posed a question for the end, getting them to think about how they could improve their performance on a similar assignment in the future (expected but not required).

Task. Resource Report and an attached template require users to write a summary of and their personal reactions to six resources (3 documents and 3 websites). Instructional Activity Design, with a required template specifying statement

Table 6.2 Model of metacognition embedded in the Piaget WebQuest

WebQuest	Metacognitive activities	Examples
Introduction	Reflection questions	What considerations should you make about teaching based on Piaget's theory of intellectual development and its educational implications?
		How could you improve your performance on a similar assignment in the future?
Tasks	Resource Report summarizing and reacting to Web-based resources (3 websites and 3 documents) using the required template	My summaries of and personal reactions to the information in each of the websites and documents
		Goals/Objectives: What do you want to accomplish? What outcomes do you expect? Your goals/objectives should use concepts consistent with Piaget's theory and its educational implications
	Plan instructional design using the required instructional activity design template	Teaching methods and learning activities: What will the teacher do? What will the students do? Provide detailed descriptions
	Assess individual work, learning and give action plan using the required self-evaluation template	How did you collaborate with your partner/group? What did you contribute? Describe and evaluate your cooperation and contributions on:
		a. Learning from each others' resources
		b. Designing and writing the instructional activity
		What did you learn from the project overall?
		If you could do this whole project over again, what might you do differently?
Evaluation (Rubrics)	Resources report	15 % grade example: Template used. All resources discussed thoroughly (summaries and personal reactions)
	Instructional activity design	15 % grade example: Complete and clear goals/objectives and specifically linked to Piaget. Teaching methods and learning activities and materials clearly and thoroughly specified; consistent with and explicitly connected to Piaget
	Self-evaluation	10 % grade example: Did very thoughtful self-evaluation of all criteria specified on the task page
Conclusion	Reflection questions	How has your knowledge of Piaget's ideas and Cognitive Constructivism changed?
		When, why, how and to what extent might you apply what you learned through this WebQuest to your own teaching?

of goals/objectives, materials/resources, teaching methods and learning activities and connections to Piaget and Constructivism; Self-Evaluation and an attached, required template for assessing their cooperation and contribution to the group process and product, what they learned from the project and an action plan for improving their future performance.

Evaluation rubric. Criteria and percent of grade for each written product using the templates with EbM activities,

Conclusion. Questions expecting students to reflect on: what they learned from engaging in this WQ, what else they would like to know, potential application of what was learned, and improvement of performance.

6.2.3 WebQuests Development

Creation of their WQs required use of the Zunal template with seven main components: Welcome, Introduction, Tasks, Process, Evaluation, Conclusion and Teacher Page, as they had experienced in the PWQ. Graduate students' WQ design and development was scaffolded throughout the semester. First they participated in the long-term PWQ I designed for them, which included EbM activities and lasted throughout the first half of the semester. Their own WQ creation began mid-semester, slightly overlapping their participation in the PWQ.

They were required to design their own long-term WQ for use with adolescents at either the JH or HS level, choosing whatever academic content they wanted. Some of their WQ design and development occurred during class time through scheduled classes in the Multimedia Center where they received feedback from each other and from me, and some of it was created by students during their own time. WQs were also discussed in the course textbook as a way of using 21st century students' interest in and pervasive use of technology.

6.3 Results

Six of the 18 WQs were developed for middle school grades 6–8 (33 %); twelve were developed for HS grades 9–12 (67 %). Subject areas included: mathematics, science, art, music, theater, documentary film making, history/social studies, and English/Language Arts. Following is a qualitative analysis of the metacognitive activities embedded in these WQs. Extensive examples are provided to convey the pervasiveness, richness and wide range of EbM activities.

It is important to keep in mind that many, but not all reflections are metacognitive, and therefore involve thinking about one's own thinking and knowledge (internal). In some cases, reflections embedded in these WQs involve reflecting on external knowledge. For example, in the Conclusion of the GM WQ, students are asked to reflect on: What do these stories tell us about the Greeks themselves? How did the ancient Greeks view their gods? Is this similar to or different from how religions of the modern world conceive of a supreme being? How? Reflections can also be affective in focus, rather than cognitive, as will be discussed later.

6.3.1 Required Versus Expected Metacognition

Two general types of metacognitive activities that emerged were "required", where there was accountability for engaging metacognitively (Table 6.3, See List of Abbreviations and Table 6.1), and "expected", where there was no accountability (Table 6.4). Metacognition was considered to be required when teachers used accountability strategies, such as observing students in class to ensure students engaged in the metacognitive activities or when they graded written answers to metacognitive questions or prompts, such as in homework assignments or journals.

Metacognition was considered to be expected when teachers posed metacognitive questions or prompts for students, but used no accountability strategies such as observation or written documentation. Required metacognition commonly was embedded in the Tasks, Processes and Evaluation pages of the WQs while expected metacognition was often embedded in the Conclusion.

A related distinction is between embedded oral and written metacognitive activities. Oral activities involved students sharing their thinking about a project with others, which will be discussed later in this chapter. Usually oral metacognition was expected but not required.

Written activities most commonly involved writing in a project journal, but also included completing worksheets, and doing homework; usually these metacognitive activities were required (Table 6.3). All JH WQs included both oral and written metacognitive activities.

All HS WQs included written metacognition and 50 % had explicit oral metacognitive activities embedded. In 33 % of the HS WQs, some communication between partners or groups was required, but it wasn't clearly specified whether it was to be oral or written, perhaps through texts or emails. In 17 % of the HS WQs there was no oral metacognition (N and RT).

6.3.2 Executive Management Metacognition

All six JH school WQs included some EMM, although it was minimal in two of them (Table 6.5). The other four (67 %) contained moderate amounts of EMM. EMM was found in several JH WQ components: Introduction, Tasks, Process, Evaluation, and Conclusion.

All of the HS WQs included some EMM (Table 6.6). Although most of it was embedded in the Tasks, Process, Evaluation and Conclusion, occasionally metacognition was embedded the Introduction. Several of the Introductions posed questions to activate students' prior knowledge so they could build on valid information and recognize and overcome misconceptions.

Table 6.3 Metacognition required in WebQuest evaluations

WQ	Evaluation criteria
S	Creativity: Invests time and thought in researching an image that directly reflects something important in their life
	Thorough exploration of how image will work as a stencil and how it will be executed
	Neatness: Uses adequate amount of ink/paint for printing
AF	Journal: Completion of assignments
	Reflections: Contributions to reflections (group and personal journal entries) and the effect they allowed it to have on their choice
GG	Project journal: Lesson summary of each lesson reflecting what you learned and your experience, and progress of your group composition
	Peer evaluation: Answer evaluation questions
A	Reflection journal: How well you learned the scientific skills and terms, how well you participated in your group, what you shared with your group members
F	Ability to reflect: Identified as something to be graded, but no details provided
Nu	Homework: Steps to solve problems demonstrate understanding and accuracy of results
GM	WQ notation guide: questions answered correctly. Thought questions carefully considered. Culminating questions structured as assigned and show deep understanding of Greek mythology. Answers were edited for conventions, spelling and grammar
	Myth creation: Personas of the gods stay true to their depictions in ancient Greek mythology
BC	Individual journal: Creation of a back-story for someone preparing for the role. Shows creativity in character choice, connects research to support character choice, constructs three dimensional character who has a clear objective, takes others' work into consideration so it affects their performance
DC	Individual collaboration journal: Documentation of project collaboration with your partner—typed cell report and actual cell model, both of which are presented to the class and turned in
N	Production proposal: Answer questions completely, proposal has anticipated story Arc including all the parts
	Presentation: Discuss why you chose your task and mention a personal experience
	Production journal: Write answers to sentence prompts about what you never thought about before and what you learned about yourself
	Peer review/Evaluation: Review any aspect of another group's work in any depth
M	Documentation Journal and Group Evaluation both use these criteria: Information is thoughtful and reflective, shows how project was accomplished, what worked well, what could have been better, how it could have been done differently
MLK and MX	Reflections in Pamphlet Created: On articles read, programs watched, and how they changed your mind about the subject (discouraging violence among teenagers using the lives and civil rights philosophies of King and X.)

(continued)

Table 6.3 (continued)

WQ	Evaluation criteria
RT	Article/Video Summaries: Comprehensive and accurate description of all major points, demonstrating understanding of the material
	Task-Specific Criteria: (#2) Clear and complete definition and drawing of a real life problem solved with the Pythagorean theorem
CD	Essay—Metacognitive Development and Assessment: Describe your experience, research methodology, difficulties encountered, memorable moments, misconceptions you had about a particular community that were cleared up, and your interest in participating in future events with that community
SCW	Journal Entries and Monologues show learner has articulated and evaluated his/her performance choices and related these to others' choices in the production
WBS	Self-evaluation: Reflect on your collaboration with your teammates. Voice any concern you may have had, what went well, what went wrong and why. Propose solutions to problems encountered to ensure your next group collaboration works better
WW	Answers to mentor text analysis questions, prewrite of your original piece, peer feedback, and final polished product are all to be graded using rubrics for each, but they're not in the WebQuest
WS	Writing process: clear, concise, well written and edited with no serious errors. Vocabulary used skillfully with precision and purpose
	Pair work: Works toward group goals, sensitive to partner's feelings, helps identify needed changes and encourages pair action for change

Table 6.4 Self-reflections expected in WebQuest conclusions

JH	*Self-reflection questions*
S	Ask yourself and each other what steps of the process you found easy or difficult?
	What could you have done to make it (your stencil) better?
AF	How did that feel? What have you seen here and what can you learn from it?
	When will you speak up?
	How will you speak up?
GG	What did you know about rhythm before this WebQuest and what did you learn from the WebQuest?
	Does this enhance your appreciation of music?
	What steps may you take in the future to further your music appreciation and learning?
	What would you like to know more about regarding music and rhythm?
A	How did the WebQuest influence your view of learning science? How will this project affect your knowledge and interest in science?
F	How did it feel to get into role as a different person? How did it feel to live through this experience in role?
	How has the experience affected you personally? What is your obligation to protect the weak?
Nu	Do you know what an IP address is? Does a number something like 192.168.1.3 look familiar?

(continued)

Table 6.4 (continued)

HS	*Self-reflection questions/Activities*
GM	Food for thought. Did you know anything about Greek myths, or mythology in general, before this WQ?
BC	When you first read the play or story what did you think of the character?
	How does some of your own personal life experience help inform your character choices?
DC	What else would you like to learn about the animal cell?
N	How can you bring information from these films into your other classes?
M	Do you think that Machinima is something that might move into the mainstream?
MLK and MX	Explain how your perspective on violence changed after this project
	Think of what King and Malcolm X did not say on violence
RT	What did this lesson teach you about the relative lengths of the sides of a right triangle?
	What about triangles that do not contain a right angle? Did you learn anything about the relative length of their sides?
CD	Have you developed a better understanding of your own ethnicity?
SCW	Does any of this information connect to anything happening in our world today? Connecting the world of the play to the world outside of the play will give you a deeper understanding of your given circumstances and your character!
WBS	What did you understand about the importance and significance of those children's sacrifices? What have they given you with their struggles?
WW	Reflections! Reflect on what you learned about writing and what you learned about yourself as a writer
	Choose the very best piece of work you did and answer the questions on the worksheet attached
WS	How do you think this special training helped you portray a person, a place or an action effectively?
	How might you use what you have learnt in this WebQuest in the future? How does your portfolio reflect what you have learnt?

For example, the introduction to "WBS" began, "What do you know about the Civil Rights Movement?

What do you know about the daily struggles African-Americans went through in their fight for equal rights?" The Introduction to the WS WQ began, "Are you ever hard-pressed on how to describe something?" This use of prior knowledge is a meaningful part of the planning process; it sets the stage for engaging in the task with heightened awareness of whether, the extent to which and how new information fits with existing schemas.

Table 6.5 Executive management metacognition embedded in JH WebQuests

WQ\EMM	Planning	Monitoring	Evaluating	Revising/Action plan
S	What type of material would you use to cut your template? How would you cut the template?	To what extent do students consider how much ink/paint they use for printing?	Ask yourself what steps in the process you found easy or difficult?	How would you do it differently if you were to cut another stencil?
AF	Create and rehearse a 3-5 min play that expresses the problem you chose but doesn't have a happy ending	Use videos and readings to reconsider the problem you chose	List the issues and solutions that stood out to you	You may decide to edit or change your problem Discuss with classmates and write in your journal what you can apply to your life
GG	Compose your own individual rhythm composition by using the rhythm chart on the Process page	Make sure you understand the material well before moving on. Let me know if you have any questions Check to make sure you have the correct duration for each measure	Reflect on and tell me what you learned from each of the individual lessons on this page Practice with the song and try to listen to see if the rhythm fits the song	
A			How did this WQ influence your view of learning science?	How will the project affect your knowledge and interest in science?
F	Create a character Write diary entries from different stages of your character's life: I am happy because…, I am sad because…, I am scared because…	Please try to stay true to your character when presenting your character to your group	What are the most important things you will take away from this experience?	How might you have changed any prior opinions you had about yourself?
Nu	Pick 3 numbers, one 1–99, one 100–999 and one 1000–9999. Use the table to show how each number is represented in the decimal system	Work cooperatively to help each other fully understand the material	Does a number something like 192.168.1.3 look familiar?	

Table 6.6 Examples: EMM embedded in high school WebQuests

WQ	Planning	Monitoring	Evaluating	Revising/Action plan
GM	Create your own ancient Greek myth	Make sure your myth stays true to the ancient Greek traditions	What was the most interesting thing you learned?	Did your understanding change in any way? How?
BC	Build a character back-story, step by step, using the guided questions		What kind of research was the most powerful to you? Why?	What changed about how you perceived the character?
DC	Testing yourself on what you know about the cell is something you can choose to do or not do. Use your own judgment and discretion	Test yourself on what you know about cells to see how ready you are for tomorrow's Quest	Ask yourself: What are three new things that you learned from doing this Animal Cell project?	Did you have any misconceptions about the Animal Cell at the beginning of the project that have now changed? What are they?
N	Come up with an original documentary idea Make counter arguments to the director's point of view		After watching these movies I never thought of ___ before. During this process I learned ____ about myself	Make suggestions on how you would do a scene from each movie differently
M	Project 1: Produce a 5 min Machinima based on a sequence from a novel or play you have studied in class over the past year. Choose your software. It must incorporate voice	You will have 4 weeks to finish your projects. Rough drafts of projects are due at the 2 week mark	What criteria would you use to judge if something was a good or successful piece of Machinima?	What would you do differently? Is this something you can see yourself using in the future for other subjects?
MLK and MX	Create a pamphlet which discourages violence among teenagers using the life and civil rights philosophies of Martin Luther King and Malcolm X	Submit drafts of your pamphlets for feedback	How do each of the resources (articles, YouTube videos, documentaries, and movie) change your mind about these men and violence?	Complete your pamphlet using feedback the teacher provides If you could interview both men what would you want them to say on what they did not say about violence?

(continued)

Table 6.6 (continued)

WQ	Planning	Monitoring	Evaluating	Revising/Action plan
RT	Devise a method of mathematically proving the Pythagorean theorem other than the ones in the five proofs provided		Do an analysis of each of the materials and describe what you learned	How could you apply this knowledge to practical experiences in your everyday life?
CD	Describe your neighborhood using pictures or videos emphasizing community or cultural centers, places of worship, public places, parks and restaurants		Describe the major influences in your family life (food, music, language if other than English etc.) Have you developed a better understanding of your own ethnicity?	In the future, will you reach out and learn as much as possible about other cultures? Has this project contributed to helping you confront your own misconceptions and clear up the confusions you have had about a particular community?
SCW	Are you going to fight?	Before performing, make sure you can answer some key questions: How old are you? Where are you from? What is your occupation?	Would you have fought in the resistance if you had lived in Spain in the 1930s? Why or why not?	How might this experience change the way you approach and read plays in the future?
WBS	Prepare 5 interview questions for someone who was around during the Civil Rights Movement	When writing the answers to your interview questions, try your best to stay true to their personal voice	Use the rubric attached to judge your own work	Each student should turn in one rewrite so there should be three rewrites in every project turned in How will you use the gifts they have fought to give you?
WW	Prewriting your own original piece could be a: brainstorm, web, list, free-write or graphic organizer	Get feedback from your partner using the sentence starters in resource #3	How is this text similar to/different from other types of these texts you've seen?	Using the peer feedback and your mentor text, create a final, polished product
WS	Write first drafts of descriptive: sentences, paragraphs and essays	Peer correction feedback on all individual work during the week	Hand in weekly work to teacher to get feedback	Evaluation criteria: helps identify needed changes; encourages pair action for change

6.3.3 Strategic Knowledge Metacognition

In some cases, the teacher provided SKM knowledge, for example, what is a stencil (declarative), when stencils have been used (contextual), and how to make a stencil (procedural), however there were few cases where students were asked to provide their own strategic metacognitive knowledge.

This same teacher was one of the few who embedded strategic metacognitive questions or tasks for students. He asked: What image would you choose? (declarative) Where would you find it? (contextual) and How would you cut the template? (procedural). In addition to these questions focusing on strategic metacognitive knowledge, they could also be considered executive management prompts for planning the stencil making process, which shows how these two main types of metacognition can overlap. At the JH school level, 3 of the 6 (50 %) of WQs embedded SKM. At the HS level, 6/12 (50 %) of the WQs embedded SKM. See Tables 6.7 and 6.8 for examples.

6.3.4 Social Metacognition

The results support the emerging distinction between personal or individual and social or group metacognition. Although traditionally metacognition has been conceptualized as a person thinking about his or her own thinking, analysis of metacognition embedded in these WQs demonstrates how pairs and groups also engage in metacognitive activities.

Table 6.7 Strategic knowledge metacognition embedded in junior high WebQuests

WQ	Declarative	Contextual	Procedural
S	Discuss what style you might work in	Explain why you chose your image	Discuss ideas and techniques about how to complete the stencil cutting process
	What image would you make?	Where would you find that image?	How would you get your image to stick to the template for cutting?
AF	Write a paragraph describing something in life that is not OK to you	Explain why the problem affects you	How will you speak up?
	What have you seen here and what can you learn from it?	When will you speak up?	
GG	What did you know about rhythm before this WebQuest and what did you learn from the WebQuest?		What steps may you take in the future to further your music appreciation and learning?
	What would you like to know more about regarding music and rhythm?		

Table 6.8 Strategic knowledge metacognition embedded in high school WebQuests

WQ	Declarative	Contextual	Procedural
N	What topics are you interested in?		How can you bring information from these films into your other classes?
M	What is Machinima? What is it not?	Why? (is it Machinima)	How can Machinima help you with your English Lit and/or Theater assignments?
	What software did you choose?		How did you choose it? (software)
MLK and MX	What do you know about Martin Luther King and Malcolm X?		
RT	Describe a scenario where the Pythagorean theorem is needed to calculate a particular length	Explain why other methods of measuring length are not feasible and why knowing the length is important	Describe in detail how the other lengths were measured
SCW	What is the relationship between the characters in your group's scene?	Why is this scene taking place?	
WBS	What might your reaction have solved in Warriors Don't Cry?	Why would you react this way?	How would things go had you been faced with the situation instead of Melba?

SM is defined as working metacognitively with at least one other person. Two forms of SM emerged in the data analysis. One is when students are partnered with another student, which is often referred to as pair or peer learning, and the other is when students work together in groups of three or more.

SM, combining pair and group metacognitive activities, was embedded in 89 % of the WQs. Two of the WQs, one at the JH level (AF) and one at the HS level (SCW) included both pair and group metacognitive activities. One WQ, M, gave students the option of working in pairs or small groups.

At the JH level, five out of six WQs (83 %) embedded SM (Table 6.9). At the HS level, 11 out of 12 (92 %) embedded SM (Table 6.10). Most often SM was embedded in the Process section of the WQS, but it also was found in the Tasks, Conclusion and Evaluation.

Pair Metacognition. Overall, 6 out of 18 (33 %) of WQs embedded pair metacognition. Only one of the JH WQs (17 %), AF, embedded pairs of students working together metacognitively. In Tasks, students were instructed, "with a partner in class …practice how to use your body to display frozen images." In Process, students were instructed "to shake hands and then freeze. One person will step out of the image and walk around it and analyze it, then insert themselves back into the

Table 6.9 Examples of social metacognition: Junior high

WQ	WQ part	SM activities
S	Process	Share your work amongst your classmates. Discuss why you chose your image, what it means to you, what you thought of the process (Ex. It was boring! It was hard! It was better than summer vacation!) and how would you do it differently if you were to cut another stencil
		…talk amongst yourselves about the process of stenciling
	Conclusion	Ask yourself and each other what steps of the process you found easy or difficult? Share your techniques. Do you think your stencil is a good representation of your image? What could you have done to make it better?
AF	Process	…talk with your classmates on how the imaging went. What were the challenges, what was interesting, how did it feel to be frozen and at the mercy of your partner?…the whole group can decide if one member's image accurately represents them all or they can combine their images to create a brand new one that shows the issue…talk with your classmates on what solutions surprised you, which solutions you could try to use it real life
GG	Tasks	You and your partners will compose an 8-measure long piece using 4 percussive instruments…. Start out by deciding the time signature…. Check your work and make sure you have the correct duration for each measure…. Practice with the song and try to listen to see if the rhythm you composed fits the song
F	Process	…as a team, the group must choose a specific movement that represents each moment, then chose a word that represents each moment
		It should symbolize each moment and please continue to stay true to your character. The rhythm and timing must be decided by the group
Nu	Process	Each group will be given a four digit decimal number…you will work together to demonstrate how each number is built. Clearly demonstrate how the value of each place is determined and the number is totaled

Table 6.10 Examples of social metacognition: High school

WQ	WQ part	Social metacognition activities
GM	Process	You will work in groups of three to create a new Greek myth! Each person is assigned a role: facilitator, note taker, or editor. Brainstorm as a group your conceptions of your gods/goddesses and how they relate to one another. Organize your conceptions. Prewrite, Compose a draft, Revise and Edit. The editor should revise and edit the draft, but other groups members are encouraged to help as well. Have a member of another group revise your draft using the peer revising sheet. Print out your final draft and present it to the audience
BC	Process	After they finish journaling, in small groups students share new insights and discoveries. Then they agree on one topic they discussed and create a tableaux
	Conclusion	How did what your cast-mates shared with you about their roles help inform your character's life in the story?
DC	Process	You and your partner will collaborate on: doing a written report on the cell, creating a Cell Model, and presenting them both to the class. Individually you will write a journal documenting your collaboration
N	Process	Peer evaluation on any aspect of another student's work and of any depth of evaluation
M	Process	Groups of 2–4 will choose one of 3 projects. Project 3: produce a Machinima documentary of 5–10 min
		Include a short group report detailing: how you chose the subject matter, what software you chose and how you chose it, your casting process, what material you included and what you decided what not to include and why. Reflection: what you think worked, what didn't and what you would do differently, and why this is Machinima
MLK and MX	Tasks	In groups of at least 5, decide which of the two civil rights philosophies you will use to make your pamphlet. You'll work on it over 3 class periods, must submit a draft and use the feedback to complete it
CD	Tasks and Process	Group Discussion: You will compare your neighborhood to other students' neighborhood emphasizing the major differences and similarities. Share why you think they have similarities with yours
	Process	Presentation: Share with your peers your essay and artwork explaining your thought process and creative process. Reflect on your experience
SCW	Task	In groups of 4 you will create scenes with the other characters based on all of your monologues
	Process	Day 1. Read your journal entry to an assigned partner. As listener, tell your partner: what did you notice, what did you like and what would you add? What were the most important parts? How did hearing it make you feel?
		Day 2: Taking the feedback from your partner, turn the journal entry into a monologue to share with the class

(continued)

Table 6.10 (continued)

WQ	WQ part	Social metacognition activities
WBS	Tasks	…groups of three will work on a project related to Warriors Don't Cry with six parts: 1. interviews by each person, 2. letter to Melba Patillo, 3. rewrite a scene from the story, 4. reaction to two websites, 5. presentation, 6. evaluation. Drafts of written work on 1–4 are submitted to the teacher and then revised based on feedback
		Reflect on your collaboration with your teammates. Voice any concern…anything that went well or went wrong. Propose solutions to any problems you may have encountered in order to ensure your next group collaboration works better
WW	Process	Get peer feedback from a partner using the sentence starters provided in resource #3
		Using the peer feedback and your mentor text, create a final, polished product
WS	Tasks and process	Pair Work: write descriptive phrases, sentences, and paragraphs. Interview your partner and write a descriptive essay as a newspaper article
		Peer correction on all individually written work
	Evaluation	Pair Work: helps identify needed changes; encourages pair action for change

image in a different position to create a whole new picture. After a moment, the other person will then step out and do the same." These activities engage students' metacognition, stimulating awareness and control over thinking by removing oneself from an image to analyze it (awareness), and then revising it (control).

At the HS level, 5 out of 12 (42 %) embedded pair metacognition activities. These activities were varied, but mainly focused on obtaining and using peer feedback, or peer evaluation. In peer evaluation one person assesses another, such as one student evaluating another's composition (written or musical).

The person being evaluated is able to use external feedback to self-evaluate his or her product and/or process and make revisions accordingly, and/or plan to improve future products/processes. However, pair metacognition also included reflecting on and evaluating the amount and effectiveness of collaboration with one's partner.

Group Metacognition. Most of the WQs, (12 out of 18, 67 %) included metacognitive group activities (three or more students working together metacognitively); most instances were embedded in the Tasks and Process components (Table 6.9 JH, Table 6.10 HS).

Group metacognition was embedded in and 5 out of 6 (83 %) JH WQs and 7 out of 12 (58 %) of HS WQs.

Group metacognition involved collaborative planning of a written project, getting feedback on it and making revisions before submitting it for a grade. It included a presentation of the project, which required additional planning activities.

Although these EbM activities involved EMM, one example of embedded group SKM is in the WQ M, where the group reported on what material they decided to include and exclude, why, and how they chose their subject matter.

6.3.5 Affective Self-reflections

Affective self-reflections (ASR) were embedded in many of the WQs; 50 % of JH WQs included them while they occurred in 67 % (8 out of 12) of HS WQs. So across school levels, 61 % (11 out of 18) of the WQs embedded ASR.

Although the question, "Have you ever felt neglected or unheard?", was at the beginning of the Introduction section of the AF WQ, ASRs occurred most often in the Conclusion sections, where they were expected rather than required.

The ASRs were commonly geared toward having students assess how they felt about the WQ experience and its impact on their attitudes about and interest in the topic. Examples of ASRs are in Table 6.11.

Table 6.11 Affective self-reflections in junior high and high school WebQuests

WQ	Level	Affective self-reflections
GG	JH	Does this enhance your appreciation of music?
A	JH	How will this project affect your knowledge and interest in science?
F	JH	How did it feel to get into role as a different person? How did it feel to live through this experience in role? How has the experience affected you personally? What is your obligation to protect the weak?
DC	HS	Most importantly, did you have fun?
N	HS	What topics are you interested in?
M	HS	What do you feel are the advantages of Machinima over other story forms?
		Is it something you'd be interested in taking up as a hobby?
MLK and MX	HS	After reading articles, watching YouTube videos, documentaries and a movie on Malcolm X, write a paragraph on each telling me how you feel about each
		What would you like to know about teenage violence?
RT	HS	Write an analysis of each reading describing what you learned and what you liked and disliked
CD	HS	Do you feel more confident in your abilities to thrive in this society?
SCW	HS	How are you (the character you created for the day the war began) feeling? How did hearing your partner's journal entry make you feel?
WBS	HS	After reading the short story Warriors Don't Cry, in your rewrite, take care to describe your feelings and motivations in great detail. Choose 2 links on this WebQuest and write one paragraph on how they made you feel

6.4 Discussion and Conclusion

WQs in this case study embedded several different types of metacognition at both the JH and HS levels, and across academic subjects. All of them included EMM. Whereas SKM was embedded in WQs at both school levels, it was not embedded in all of them. Some of the EbM activities were required while others were expected.

Required metacognitive activities were embedded in the Tasks, Process and Evaluation sections of the WQs most frequently, helping to ensure that the assignments were executed properly.

Although expected metacognition was embedded in some of the Task and Process components, it occurred most often in the Conclusion sections of the WQs in this study. Teachers embedded questions asking students to reflect on their WQ experiences regarding what they learned, how it might impact them in the future, and how they felt about the experience. These are worthwhile and key reflections, so it would make the WQ experience richer, more powerful and fruitful if there were accountability structured into these WQs reflections to help ensure that they actually occur.

Teachers may not appreciate that metacognitive questions and prompts are essentially optional for students if there is no accountability structured in the WQ process, such as through written work, grading and/or observation.

Research is needed to examine variables affecting whether, the extent to which and how students engage in metacognitive activities when they are expected but not required. Research should also address how to design WQs that make required metacognitive engagement more pervasive and effective.

The types of self-reflections examined here can overlap across each other and within a category. EMM can overlap with SKM, for example, as when SKM declarative knowledge, "Describe a scenario where the Pythagorean theorem is needed to calculate a particular length" can also be viewed a step in the planning process (EMM) where devising and solving such a problem is a required academic task. EMM can also overlap within this category.

For example, monitoring can overlap with evaluating when one gets feedback while creating a product and using that feedback to improve the product. By definition, developing an action plan, which is based on evaluation, overlaps with planning, as figuring out how to apply what you have learned from an experience leads to developing a new course of action for the future.

EMM can also overlap with affective-self reflections. For example, evaluating what you liked or didn't like about a project (EMM) involves considering one's own interests, attitudes, values and/or motivations (ASRs).

Cognitive reflections embedded in the WQs in this study include "reflection on action", either before or after a task, as in planning and evaluating and "reflection in action", as monitoring during a task [51]. Friere's [52] concept of praxis is a kind of political and educational metacognition where one reflects on the world and engages in actions to improve it. This concept is similar to EMM, using the results of a self-evaluation to develop an action plan which transforms a product, process or situation so that it is better. Several of the WQs discussed here require or expect students to engage in this type of thinking.

Almost all of the WQs in this case study had resources for individuals, groups and/or pairs to use for learning about the content and designing and implementing their projects attached at the bottom of the Tasks and/or Process pages. These included documents, such as articles to read, as well as design and assessment templates; websites with important information, and YouTube videos. When my students presented their WQs to our class in May, 2011, all these resources were available and I checked them all out subsequently when grading this assignment. However, by January, 2014, these resources were no longer available, and I do not know why. This is clearly a problem with the Zunal WQ site, and one that needs to be considered for others who might consider using it. Resource websites that were embedded directly in the Zunal pages (rather than attached at the bottom) are still available. For some unknown reason, fortunately all of the resources for my PWQ attached at the bottom of the Tasks and Process pages are still there.

This study differs from others examining metacognition in WQs in several ways. Research on metacognition in language-learning related WQs primarily focuses on EMM. The studies of employing metacognitive strategies to enhance speaking and writing English do not address SKM and do not explicitly include affective self-regulation [38, 39] although the Li study included data on attitudes toward oral English and oral English instruction [38].

Questionnaire items such as, “I am satisfied with my oral English” and “I am satisfied with current teaching methods in oral English class” [38] could have been identified as ASRs. While most of the other research on metacognition in WQs specifically sought to see how the WQ format could be used for developing metacognitive approaches to learning, the WQs in this case study focused on learning content, however metacognitive activities were deeply and pervasively embedded in most of these WQs to help achieve the content learning goals and objectives. Although, one of the WQs identified metacognition as a process for development and assessment, most explicitly called for students to reflect on their WQ learning experience thereby emphasizing that students should have *awareness* of their own thoughts, knowledge or feelings.

Almost all of the WQs also asked students to consider revisions or action plans—how they might have done things differently, or better, and/or how they might use what they learned in the future. These reflections emphasize learner *control*—another key dimension of metacognition and affective self-regulation.

One of the limitations of the current study is that it did not investigate whether, how and the extent to which EMM and SKM embedded in WQs resulted in a metacognitive approach to learning that transferred to other academic tasks, in computer-supported learning environments, in the regular classroom, and to non-academic contexts. Also, it is not clear whether or to what extent the EMM and SKM embedded actually affected learning outcomes, such as the products created through the WQ tasks and processes and the ability to transfer what was learned. Research shows that without contextual knowledge, learners are often unable to apply what they have learned, and the declarative and procedural knowledge they have acquired remains inert because of lack of awareness when a situation calls for transfer of what has been learned. These are issues that should be addressed in future research on WQs.

Most, but not all WQs required students to work in pairs or groups and involved SM. These metacognitive activities primarily emphasized executive management processes. There were more group than pair metacognitive activities. The findings here on SM embedded in WQs for adolescents complement Chan et al.'s research on adolescents' work on the simulation, Collisions, where computer scaffolds were designed to support collaborative inquiry and co-regulation. The peer questioning strategies to promote metacognition embedded in several of these WQs are different from the approach developed by Choi et al. [53] because in the WQs in this case study, specific metacognitive questions were assigned to students whereas in the Choi et al. approach, scaffolding was used to help students generate their own metacognitive questions. Future WQ design might include embedding similar SM scaffolding strategies to help students develop self-questioning skills for learning metacognitively.

Future research on SM in WQs might follow the lead of Janssen et al. [28] and look at the impact of co-regulation on the quality of the group product produced through collaboration in a computer-supported environment. Also future research may systematically examine co-regulation by pairs and groups to identify similarities and differences in the cognitive processes used, their impact on affective self-regulation, and their effectiveness in achieving targeted learning outcomes, especially in comparison with WQs that do not use SM.

Additionally, when a group member serves a metacognitive function, such as having a cooperative learning role to revise and edit a group product based on feedback from members, or verify the solution to a problem, research should identify strategies for ensuring and assessing metacognitive contributions by all members of the group.

A few of the WQs had more of an emphasis on affective than cognitive reflections, while most had more cognitive than affective. Some WQs had no affective self-regulation. WQs might be enhanced by embedding and requiring both cognitive and affective self-regulatory activities. Also, WQs might more explicitly explain to and train students in EMM and SKM and affective self-regulation as WQ goals, in addition to, and as a facilitator of, content learning and transfer to new situations.

Finally, WQs might be enhanced by embedding both personal and social required metacognitive activities.

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