

E-Adoption and Technologies for Empowering Developing Countries: Global Advances

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Chapter 14

Wiki Interaction Tracks in Geometry Learning

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ABSTRACT

The constant comparative method (Lincoln & Guba, 1985) was used to analyze preservice teachers' discussions and interactions in wiki discussion sections regarding geometric lessons that were written by other preservice teachers in the year before. The data was compared for the following interaction aspects of knowledge building: dialogical actions, participants' roles, and discussion tracks. Research shows that building their content and pedagogic content knowledge, the preservice teachers together with the lecturer used mainly proposing, asking, requesting, arguing, presenting, and moving the discussion forward as dialogical actions. Proposing and asking were used for various goals such as proposing various ideas and actions, and asking about different issues concerned with geometric content and pedagogic content knowledge. The lecturer asked questions more than the preservice teachers, while the preservice teachers proposed more than the lecturer. The knowledge building was collaborative in nature, and one important aspect which enabled the collaboration is the topology of the wiki discussion section. This topology enables presenting the content of the messages; not just the titles, where the contents are presented as having the same level and thus the same importance.

INTRODUCTION

Wikis are used and constructed by students for various targets. Taylor (2006) describes the advantages that wikis offer: (1) it is available 24 hours a day (2) it is easy to navigate, easy to be searched

and easy to make contributions to (3) Changes, new information and successful improvisations can be quickly documented, and (4) new, revised or alternative worksheets can be attached for subsequent use by anyone. Grant (2006) says that "Wikis have been heralded as one of a number of new and powerful forms of software capable of

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supporting a range of collaborative ventures and learning activities.” Forte and Brukman (2007) say that wikis can be used by students not just as a kit for writing to learn, but a kit for public knowledge building in schools. Head and Eisenberg (2009) found that higher education students use Wikipedia as a unique and indispensable research source for conducting their researches. They add that this collaborative, community-based online source gave students a big picture and language contexts for their research projects. Head and Eisenberg (ibid) report that in 8 out of 11 of the student discussion sessions there was a strong consensus among students that their research process began with Wikipedia.

The wiki technology then serves various educational functions for teachers and students. So, preservice teachers would benefit from being introduced to this technology.

LITERATURE REVIEW

Wikis in Education

Tonkin (2005) identifies four categories of the wiki use in the education field:

1. Single-user: This use allows individual students to write and edit their own thoughts. So, it’s useful for revision and monitoring changes in understanding over a period of time.
2. Lab book: This use enables students to peer review notes kept online by adding commentary, annotations or other additions to existing lecture notes, seminar discussions, lesson plans, etc.
3. Collaborative writing: This use can be used by a team for joint project or research such as a group initiative, essay or presentation.
4. Knowledge base: Through collaborative entries, students can create course content

that supplements and extends delivered material.

Challenges to Wiki’s Use in Education

Reynard (2009) points at three challenges to wiki use in instruction. The first challenge is to create meaningful assignment to motivate students’ learning. Reynard suggests that this can be done through: building a dynamic and not static assignment, the assignment should demand every student fully participating, and the assignment should use students’ participation to move their learning forward. The second challenge involves grading the students’ work in the wiki environment. Reynard (2009) says that students should be graded for all their work’s stages in the wiki environment, where the grading should take into consideration the following stages: working with and building on existing information, inputting new information, and synthesis of information into useful ideas for the project or work at hand. The third challenge to wiki use in instruction is the kind of collective knowledge requested in the assignments. Assignments should involve complex problems which don’t have obvious or preset solutions, and students should have adequate time for carrying out these assignments collectively.

Leuf and Cunningham (2001) suggest that wikis can support the delivery of class curriculum and projects, as well as the discussion during the process of creating and sharing knowledge. Raman, Rayn, and Olfman (2005) examined the use of wikis in facilitating the creation of a knowledge management system. They chose the wiki technology for its following characteristics: (1) Wiki technology is easy to install (and free), (2) Wiki technology provides capability for easy access and editing, (3) Wiki technology allows a class to develop a knowledge base readily, and (4) Wiki technology can aid knowledge creation and sharing in both corporate and academic settings.” Raman, Rayn, and Olfman (ibid) found that the

students lacked initiative and the enthusiasm to discover for themselves how best to maximize the value potential of wiki technology. Furthermore, they concluded that effective implementation and use of a wiki to support knowledge management for effective teaching and learning is contingent upon familiarity of both students and instructors with the technology, level of planning involved prior to system implementation and use in class, class size, and the ability to motivate students to learn from one another based on the principles of discovery learning

Effectiveness of Wikis as Learning Environments

Coutinho and Bottentuit Junior (2007) describe a collaborative learning experience of post graduate students who attended a program on research methods in education, where the experience involved the use of wikis in advanced collaboration. They point that the feedback received from students shows that wikis can be effective in learning environments; however, the evidence obtained, regarding the potential of wikis to promote learning in the ZPD zone, was clearly inconclusive: students enjoyed working in groups but they did not believe group works to have better quality; neither that they learned more working in teams than working individually.

Wikis as Collaborative Educational Environments

Kessler (2009) studied student-initiated attention to form in wiki-based collaborative writing among pre-service Non-Native Speaker (NNS) English teachers. He found that the overall tendency among these NNS English teachers, when editing each other's wiki-posts, was to focus on meaning rather than form. When the teachers revised the form, they did so with some additional attention to the content, so this revision of form wasn't just an isolated incidence of error-correction. The teach-

ers deferred to meaning, design and style rather than grammatical errors. When asked to explain their behavior, the teachers responded that they didn't attend to grammatical errors because they had no problem understanding the meaning of the sentences.

Grant (2006) described a wiki project in which three ICT 9th grade classes took part. The teachers assigned students to random groups of between six and nine students, each with their own separate wiki. The students were required to work in their groups on a history-based research project regarding innovations in technology since 1950. They were asked to present their project in the wiki. Grant (ibid) says that the students worked on their own wiki pages, and very few edited material on others' pages. The interviewed students agreed that it was better to write one's own page rather than edit someone else's. From the other side, the students considered commenting on each other's design of the wiki pages as acceptable and legitimate practice, and did so. The author concluded that knowledge-building network did not arise in this experiment, and explained that this happened because the students imported practices of individualized written texts and assignments from their school community.

Wilkinson and Huberman (2007) pointed at the following measures that serve to compute the collaboration in editing an article in wikis: (1) the number of edits on an article, (2) the number of contributors, (3) visibility or relevance of the article, and (4) age of the article. Meishar-Tal and Tal-Elhasid (2008) say that in educational wikis, the number of contributors shouldn't be taken into account when measuring collaboration, and instead the relative diversity of contributors should be taken into account. They define relative diversity as the ratio between the number of actual contributors and the number of potential contributors. For example, potential contributors could be the number of group members who work on a wiki article. Meishar-Tal and Tal-Elhasid added to the previous measures another measure which

they called ‘intensity’. They defined ‘intensity’ as the number of edits that the contributors did; this should be taken into account proportionally to the relative diversity of the collaboration.

Wikis as Environments for Educational Dialogue or Interactions

Cohen (2009) described the process of creating a mathematical dialogue by means of a collaborative editing of a wiki document about the mathematical term ‘function’. She reported that the majority of practitioners who were involved in her research did not participate in editing the term, saying that they experienced difficulty with an on-line dialogue as opposed to face-to-face discussion. At the same time, the participation of the practitioners who participated in editing the term contributed to an improvement in the information about the term “function”.

Aharony (2008) found the following types of interactions in the discussion section of a wiki that was constructed by 19 undergraduate second-year students who participated in an information-management academic program: Courtesy, instructor’s comments (supportive comments, style and bibliography, substantive comments), students’ constructive comments (structure and bibliography comments, clarification, expanding the assignment, deep comments), and students’ response to their classmates (communication with the instructor, emotional reaction, technical and structural comments, appreciation, direct response to other students’ comments, substantive deep comments).

Research Rationale and Goal

Robinson (2006) says that the use of wikis in education has increased dramatically over the last few years, and wiki entries and conference sessions abound. He adds that there is still a lot of confusion about what wikis are and how to use them. Though much of this confusion has cleared in the past three

years, there are still many issues regarding wikis use in education that should be researched. One such issue is the discussion potentialities of the wiki environment. One essential component of an electronic learning environment is the forum which facilitates communication among the participants of the learning environment. In the case of the wiki environment we have the discussion section which enables communication among the participants. What potentialities does this section have? Which dialogical actions and tracks of actions does it facilitate? The questions are especially important in the case of learning geometry. Various researchers point at the importance of learning geometry for school learners and the difficulties that those learners confront learning it. Providing preservice teachers with a building tool of geometry lessons (as the wiki) should be a key component of their teaching preparation, for it would help them to a great extent in their future teaching of geometry. This preparing won’t be efficient if it doesn’t include a discussion tool that enables them to discuss geometry lessons. This research wants to examine the potentialities of the wiki environment to enable various types discussing actions and tracks of actions regarding geometry lessons. Doing so will make us know if wiki provides an appropriate environment for teachers and learners to discuss geometry lessons, teaching and learning.

Research Questions

1. What dialogical actions do preservice teachers carry out when discussing wiki-based geometry lessons?
2. What discussion tracks of actions are preservice teachers engaged with when discussing wiki-based geometry lessons?
3. What learning and teaching roles do preservice teachers and their lecturer play when discussing wiki-based geometry lessons?

Methodology

Research Setting and Sample

The study was carried out in a college wiki. This wiki is used by the college preservice teachers for various learning goals: describing and discussing their projects, writing and discussing their assignments, writing lessons, etc. In this research I will examine the discussion pages in the geometry wiki. These pages are involved with discussing geometry lessons that preservice teachers from former years built. The preservice teachers who built the lessons and those who discussed them are second year preservice teachers in the mathematics department. This study examines the discussions held in the first semester of the academic year 2008-2009 by 26 preservice teachers, regarding the lessons built in the first semester of the academic year 2007-2008 by 24 preservice teachers.

Working in a wiki environment, second year preservice teachers of the mathematics specialization who participate in the advanced geometry course go through three stages with their wiki environment learning: (1) examining and discussing geometry lessons that were built by preservice teachers from the previous academic year (2) editing the lessons according to the discussion in the first stage, and discussing this editing (3) writing new geometry lessons. This study reports the first stage of working with the geometry wiki

Data Collecting Tools

The data was collected from the discussion sections of 24 wiki pages which included a geometry lesson each. These discussion sections had one to four discussion themes each. Table 1 describes the number of wiki discussion sections that had one theme, two themes, etc.

Table 1. distribution of the number of themes

Number of themes	Number of wiki sections
1	4
2	8
3	7
4	4
Total number of wiki sections	23

Data Analyzing Tools

The texts in each discussion section (57 texts in total) were analyzed using the constant comparative method, as described by Lincoln and Guba (1985). This method compares the data until categories and themes emerge. The data was compared for the following interaction aspects: dialogical actions, participants' roles, and discussion tracks. Dialogical actions are the actions that the participants in the discussion do during their discussion, for example criticizing, notifying, etc. The participants' roles are the roles that the participants in the discussion play towards each other, for example watching, directing, etc., and the discussion tracks are the sequences of actions/interactions during a discussion; for example ask – inquire – argue - explain.

FINDINGS

The Teacher's Dialogical Actions and Role in the Wiki Geometric Discussions

Acceptance Dialogical Actions

The teacher accepts:

After various dialogical actions, the teacher sometimes accepted a student's definition, suggestion, argument, etc.

The teacher accepts with withdrawal:

Sometimes the teacher accepted the main claim of the student and at the same time criticized part of it. For example, the teacher accepted a student's claim that a square is a rectangle, but criticized mentioning the length of edges in the definition.

The teacher accepts and promotes the discussion further:

The teacher usually didn't just accept the students' statements but promoted them further, for example, when a student claimed that two intersecting lines reminded her of an angle, the teacher required her to compare the two situations and discuss their similarities and differences.

The teacher supports:

The teacher supported students when suggesting a right suggestion or raising an important issue, for example when suggesting correctly using a specific term in place of another one, or when suggesting to give different examples on a term and not just one.

The teacher argues:

The teacher argued regarding: (1) the correctness of a student's claim (2) the efficiency of a student's suggestion.

The teacher confronts and promotes the discussion further:

The teacher confronted some students' claims, giving them new information and asking them to think about the issue again. Sometimes the teacher confronted the students' claims by showing them the contradictions in those claims.

Notifying Dialogical Actions

The teacher informs:

Sometimes the teacher wrote just to inform the students that he was following their discussions. The teacher also wrote to inform the students (1) about a formatting problem, for example not writing the angle symbol using the wiki language (2) that there was no link between a page and the previous page (3) that a definition did not follow a specific criterion.

The teacher acknowledged the students' contribution:

Usually this was done when a student claimed a correct claim, suggested a good suggestion, attracted the attention to an important point, etc.

The teacher encourages:

In this case, the teacher encouraged the students to participate in the discussion, for example by asking them about their opinion, their preference or their history regarding the learning of geometry.

The teacher attracts the students' attention:

The teacher attracted the students' attention to other dimensions of the issue discussed, for example that the discussed issue is not only about the aesthetic of a definition, but also about its being ambiguous or clear.

The teacher moves the discussion forward:

Doing so, the teacher requested students to elaborate more on their comments, suggestions or opinions.

Requiring Dialogical Actions

The teacher asks:

When asking, the teacher asked about the following: (1) how to define a geometric term, (2) what alternative definitions there are for a specific geometric term, (3) whether a definition fulfills some definition criterion, (4) whether a definition is sufficient (5) the difference between a given definition and a proposed one (6) the efficiency of a suggested definition.

The teacher requests:

When requesting, the teacher requested the students to: (1) go to geometry books or to the internet to look for the definition of a geometric term, or how a specific topic is introduced, or how a theorem is proved (2) find alternative definitions for a specific geometric term.

Suggesting Dialogical Actions

The teacher proposes:

The teacher proposed to (1) add drawings to a lesson (2) write mathematical formulae algebraically and verbally at the end of presenting a new topic.

The teacher gives an opinion:

The teacher gave his opinion regarding content and pedagogic content knowledge, for example, what it means to define, what it means to write geometric proof, etc.

The teacher defines:

The teacher gave an exact definition when the students discussed this definition but couldn't arrive at its exact statement.

The teacher describes:

For example the teacher described how to write mathematical formulae in the wiki language

The Teacher's Roles

The teacher played different roles, writing in the wiki discussion section. These roles varied, starting from watching what was going on in the discussion section and ending with presenting the participants with information. Between those two ends, the teacher had different roles; for example, directing, motivating, encouraging. I will describe these roles below:

The teacher watches:

Sometimes the teacher watched what was going on without interfering. This usually happened when the students could manage their geometry learning alone.

The teacher directs:

The teacher directed the students by informing them, asking them questions, proposing to them alternative actions, requesting them to do specific actions, or moving the discussion forward.

The teacher motivates:

The teacher motivated students to pursue their study regarding geometry concepts by accepting their claims, supporting them, and implying directions of examinations.

The teacher encourages:

The teacher encouraged students to pursue their study by acknowledging their contribution, and by talking to them by names or as members in the same learning group as him.

The teacher presents:

Sometimes the teacher presented information to a participant or participants. This usually happened after some discussion to which students contributed but couldn't arrive at the exact concept, idea or statement.

The Student's Dialogical Actions and Role in the Wiki Geometric Discussions

Acceptance Dialogical Actions

The student accepts:

The student accepted the teacher's and other students' suggestions or ideas, for example that a lesson should include a suggested definition or drawing.

The student accepts and promotes the dialogue further:

Sometimes, students, not only accepted a suggestion or an opinion, but promoted it further, adding to it or explaining why it is correct.

The student argues:

The students argued regarding: (1) the correctness of a proof (2) the correctness of a definition (3) the appropriateness of a lesson's element to the goal of the lesson (4) the need to prove the formulae that we give to pupils.

The student criticizes:

The students criticized: (1) the absence of a definition for a specific term (2) the inexistence that a definition criterion is not satisfied (3) the statement of a definition (4) the absence of a drawing in a lesson (5) the absence of sufficient

examples in a lesson (6) the absence of sufficient exercises in a lesson (7) formatting aspects of the text, like the font size or the background color.

Notifying Dialogical Actions

The student informs:

The students informed others regarding finding some problems with the text that they read, for example, one student wrote that she didn't find a needed definition for the rectangle in the lesson.

Requiring Dialogical Actions

The student asks:

When students asked they asked about issues similar to those that were mentioned by the teacher. In addition students asked about (1) design issues like the formatting of a wiki page or the appropriateness of a picture to a geometric subject (2) the meaning of a specific sentence or a word in a sentence (3) the reason for a specific feature of the lesson, for example the absence of exercises in a lesson.

Suggesting Dialogical Actions

The student proposes:

The students proposed to: (1) change some formatting aspect, like the font size or color; introduce a geometric topic in an alternative way, (2) change the definition of a specific term (3) how to teach a specific topic (4) how to correct a proof of a specific theorem (4) how to write a specific equation (5) include a specific drawing (6) include a specific element in the definition of a geometric term (7) write answers for the exercises (8) how to teach a specific topic.

The student gives an opinion:

For example regarding how a topic should be presented to students.

The student explains:

When the student explained, she explained a suggestion that she suggested, a claim that she claimed, etc.

The student defines:

Usually, the students defined geometrical terms, like shapes.

The student describes:

Usually students described the properties of geometric shapes.

The student corrects:

Usually, students corrected their writings according to the feedback they got from the teacher or other students.

The student presents:

The students presented what they were required to do, for example, they presented a definition or the correction of a definition, or examples on a new topic, etc.

The Students' Roles

The students' main roles were: watching, presenting, arguing and directing.

Dialogic Tracks

Now I describe the tracks of dialogic actions which the students and teacher were involved with. Figure 1 describes one such dialogical track.

Figure 1 is an example of a 'solo' track. This is a track which involves just one participant. It can be characterized further as: a student dialogue, a dialogue which has one message, a dialogue which has three types of contents (criticizing, explaining and proposing), a non-saturated dialogue; i.e., a dialogue that could have been continued: the student could have been required to give a complete proof according to her explanation.

Figure 2. describes a second dialogical track.

Figure 2 is an example of two-participant track, a track which involves two types of participants; one student and the teacher, a track which has four types of contents: suggesting, informing, correcting and asking. It's also an example of a track of a 'saturated' dialogue. This is a dialogue which couldn't be pursued further. It's also a five-message track.

Figure 3 describes a third dialogical track in another wiki geometry lesson.

Figure 3 describes two-participant track, a track which is teacher-involved, a four-message track, a track of 6 types of content: informing, defining, describing, asking, presenting and requiring. It's also a non-saturated track, because the student could have pursued the dialogue but he didn't do so.

Figure 1. A dialogical track in the discussions section of one wiki lesson

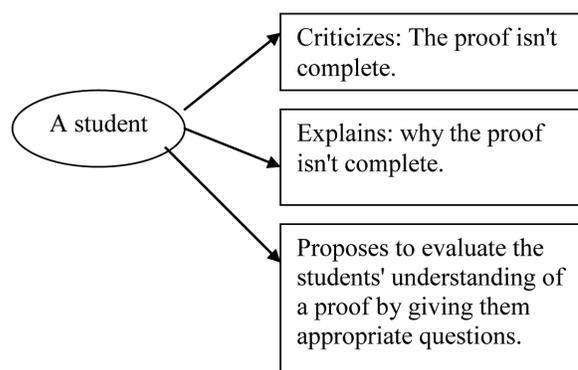


Figure 2. A second dialogical tracks in the discussions section of a wiki lesson

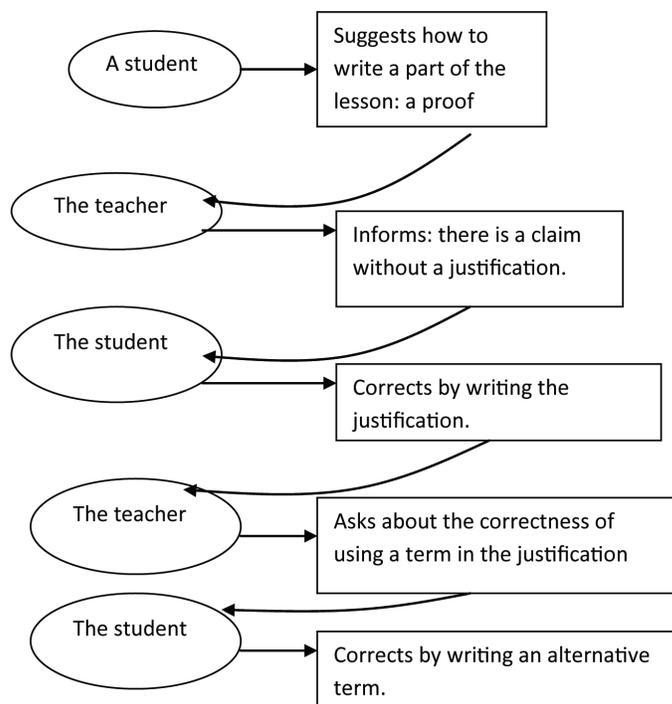


Figure 3. A dialogical track in the discussions section of another wiki lesson

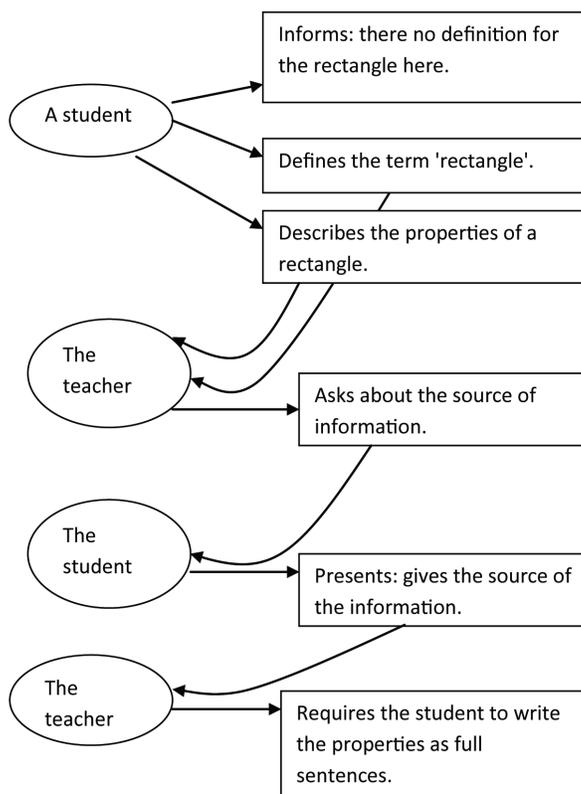


Figure 4. A different dialogical track in the discussions section of another wiki lesson

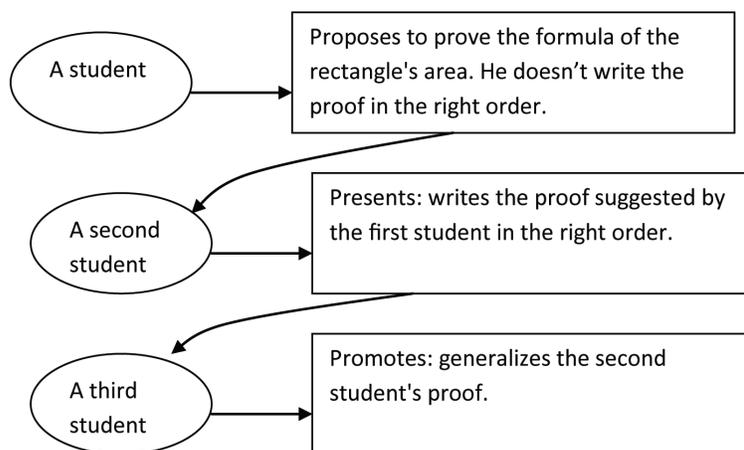


Figure 4 describes students-only track of dialogic actions.

Figure 4 is an example of a multi-student track. This is a track in which the teacher didn't interfere. Other characteristics of the track are: a three-student track, a three-message track, a track that involves three types of content: proposing, writing and generalizing. This track could be considered saturated.

So, dialogical tracks in the wiki discussion sections can be characterized according to the following six aspects: (1) Number of participants (2) Type of participants (3) Number of dialogue contents (4) Types of dialogue contents (5) Number of messages (6) Saturation of the dialogue. In addition to these characteristics, wiki dialogical tracks can be characterized according to (7) the order of its dialogical actions.

The following tables describe the distribution of the dialogical tracks according to those categories.

Table 2 describes the distribution of dialogical tracks according to the number of participants participating in them.

We see from table 2 that in most of the wiki tracks 2-4 participants were involved.

Table 3 describes the distribution of dialogical tracks according to the type of participants participating in them.

We see from Table 3 that the teacher was involved with more than half of the dialogical tracks.

Table 4 describes the distribution of dialogical tracks according to the number of dialogue contents.

Table 2. Number of participants in the dialogical tracks (N=57)

Number of participants	Percent of wiki tracks
1	12.28%
2	22.81%
3	42.11%
4	19.3%
5	3.5%

Table 3. Type of participants in the dialogical tracks (N=57)

Number of participants	Percent of wiki tracks
Students only	47.37%
Students and the teacher	52.63%

Table 4. Number of dialogue content types in the dialogical tracks (N=57)

Number of dialogue content types in one wiki track	Percent of wiki tracks
1	8.77%
2	12.28%
3	22.81%
4	33.33%
5	12.28%
6	10.53%

Table 4 shows that more than half of the dialogical tracks were involved with three to four dialogue contents.

Table 5 describes the distribution of dialogical tracks according to the type of dialogue contents.

Table 5. Types of dialogue contents in the dialogical tracks (N=57)

Dialogue content in one wiki track	Percent of wiki tracks
Acceptance: • Acceptance • Acceptance with withdrawal • Criticizing • supporting • Accepting with promoting • Confronting with promoting • Arguing	• 8.77% • 12.28% • 12.28% • 8.77% • 8.77% • 10.53% • 43.86%
Notifying: • informing • acknowledging the students' contribution • encouraging • attracting the students' attention • moving the discussion forward	• 10.53% • 10.53% • 10.53% • 10.53% • 35.09%
Requiring: • Asking • Requesting	• 36.84% • 24.56%
Suggesting: • proposing • giving an opinion • explaining • defining • describing • correcting • presenting	• 61.40% • 8.77% • 17.54% • 29.82% • 10.53% • 10.53% • 75.44%

We see from Table 5 that 'suggesting' is the main category of dialogical actions used by the wiki participants to discuss geometry, its learning and teaching.

Table 6 describes the distribution of dialogical tracks according to the number of messages.

We see from Table 6 that most of the dialogical tracks had 3-4 messages.

Table 7 describes the distribution of dialogical tracks according to the Saturation of the dialogue.

Table 7 shows that most of the wiki dialogical tracks were saturated or almost saturated regarding the treatment of the issue they involved. Issues that were not saturated were not treated at all, issues that were semi saturated were treated but one of the issues that they involved was not treated. Issues that were almost saturated involved issues that were almost fully treated but one participant at least didn't carry out a requested action, for example he was required to explain why he used a specific term but didn't give any explanation. Issues that were saturated had issues which were all completely treated

Table 6. Number of messages in the dialogical tracks (N=57)

Number of messages in one wiki track	Percent of wiki tracks
1	5
2	7
3	21
4	24

Table 7. Saturation dialogical tracks (N=57)

Saturation type	Percent of wiki tracks
Not saturated	8.77%
Semi saturated	19.3%
Almost saturated	38.6%
Saturated	33.33%

Order of Dialogical Actions in a Track

Some tracks started with proposing which is a 'suggesting' dialogical action:

- Proposing – arguing – asking – defining – arguing - defining.
- Proposing – arguing – asking – presenting – arguing – presenting – asking – presenting.
- Proposing – arguing – supporting – asking – presenting – asking.
- Proposing – arguing – asking - arguing.
- Proposing – asking – arguing – notifying – presenting – asking.

Other 'suggesting' dialogical actions which started wiki tracks were: giving opinion and presenting, as in the following tracks:

- Giving an opinion - arguing - proposing - presenting.
- Presenting - accepting with withdrawal – asking – asking - presenting.

Other tracks started with an 'acceptance' dialogical action:

- Rejecting – proposing – arguing – asking – arguing – presenting.
- Confronting – presenting – asking – presenting – proposing – arguing – asking – arguing – accepting and promoting – asking – arguing – presenting.

Some tracks began with a requiring dialogical action:

- Asking – arguing – arguing – presenting – asking – arguing – presenting.

As could be seen, when tracks began with proposing, arguing or asking followed and then a suggesting action. When we have a saturated track,

it ends with presenting. It is also noticeable that an accepting action follows a suggesting action.

Interactions

There were various types of interactions between the participants in the wiki discussion section. Initiated teacher's or student's dialogue triggered different types of dialogic actions and interaction. Below I describe the different types of triggered actions and interactions.

Table 8 describes the actions/interactions triggered by a student's initial actions.

DISCUSSION

Dialogical Actions

Augar, Raitman, and Zhou (2004) say that wikis can be used to facilitate computer supported collaborative learning, CSCL. This is what happened in the reported preservice teachers' learning that occurred in a wiki environment: second year preservice teachers collaborated to discuss and deepen their knowledge in geometric content and pedagogic content knowledge. Collaborating, they did various dialogical actions. These dialogical actions are of four main types: Accepting, notifying, requiring and suggesting. These four types are of complementary nature: accepting is used to exchange ideas and move the discussion forward. Notifying is used for administrative goals; especially to direct the participants and promote learning. It was used not only by the teacher but by the students too. Requiring is used to make the participants do things, and suggesting is used to give some goods for the participants. It could be suggested that these four components are essential for effective and successful learning in any learning setting, especially the electronic setting.

Table 8. Triggered actions/interactions by initiated actions

Initial action	Triggered actions/interactions
Proposing	Accepting the proposal, acknowledging the importance of the proposal, supporting the proposal, rejecting the proposal, requiring the clarifying of the proposal, discussing the proposal, developing the proposal.
Asking	Trying to answer, giving implication of the right answer, proposing a way to the right answer, giving information, and arguing.
Requesting	Clarifying, trying to do, doing.
arguing	Arguing, accepting, supporting, rejecting.
explaining	Arguing, supporting, rejecting, requesting further explanation.
Giving an opinion	Arguing, supporting, rejecting, requesting further explanation, giving opinion.
defining	Accepting, rejecting, and arguing with or against the definition's statement.
describing	Accepting, rejecting, and arguing with or against the description's statement.
correcting	Accepting, rejecting, and arguing with or against the correction.
Informing	Accepting, rejecting, arguing with or against what is informed, and doing according to what is informed.
Implying	Clarifying, explaining, and doing as implied.
encouraging	Doing,
Criticizing	Accepting, rejecting, arguing with or against the criticism, and doing according to the criticism.

Dialogical Interactions

Augar, Raitman, and Zhou (2004) point that wikis enable the exchange of ideas and the facilitation of group interaction. This research looks at three aspects of this exchange: the type of participants in the exchange, the triggered actions/interactions from a dialogical action, and the tracks that represent this exchange.

Regarding the triggered actions/ interactions, we saw that a dialogical action may result in various actions/ interactions. The dialogical actions that triggered more actions/ interactions were proposing and asking. Proposing and asking were wide range actions; they were used to propose various ideas and actions, and ask about different issues that were concerned with geometric content and pedagogic content knowledge. The teacher asked more than students, while students proposed more than the teacher. This can be explained by the directing role of the teacher who asked to direct the students to verify or develop geometric concepts, while he didn't propose directly ideas or actions because he probably wanted the students to ar-

rive at these actions and ideas by themselves, as a consequence of his directing. Thus the study of geometry and geometry writing and teaching, in the wiki dialogical environment, was characterized by a teacher who directed and students who exchanged ideas and suggested taking specific actions. The discussion of the two other issues regarding the participants' types and the dialogical tracks will follow.

Participants' Roles

The Teacher's Role

The teacher's role can be summarized as: watching, directing, encouraging, motivating, and presenting. As reported in the finding, the teacher played the presenting role scarcely; when the students didn't arrive by themselves at the exact definition of a geometric term or the proof of a geometric theorem. This happened after discussing the definition or the proof with the students. Thus the main role played by the teacher was directing. Bjørgen (1991), as reported by Ljoså

(1998), describes four different conceptions of what it means to be a teacher: (1) the sculptor who takes full responsibility for the presentation of all relevant material and controls the schedule, the curriculum and the work of the students (2) The entertainer who feels responsible for arousing the interest of the student and make it easy for them to grasp the central issues of her subject (3) the coach who believes that results depend on the work done by each student, and sees himself as catalyst for this work. (4) The manager who looks at the classroom as a working place, and considers her task to be managing the joint efforts effectively towards the best possible result. The role of the teacher, in the wiki geometry learning that this article reports, is more a coach than any other role, but he also was a manager and an intertainer.

The Student's Role

The students' main roles were: watching, presenting, arguing and directing. The students did more presenting than the teacher because this is what they were expected to do when suggesting changes to improve the wiki geometric texts. Arguing was one of the main dialogical actions of students because this is how they defended or justified their suggestion. Overall, the students' role was to develop last year students' knowledge and, doing so, to produce their own knowledge. Discussing last year students' knowledge and suggesting ways to develop it turned the knowledge from acquired into constructed. The students not only constructed their own knowledge but directed other students to build their own knowledge. The students weren't independent in deciding what to learn, but they were independent in deciding which text to discuss and which aspect of the text to treat. They were also independent in their choice of other students to direct or accompany in the process of building geometric knowledge. It can be said that the students were active partners in the building of geometric knowledge (Sperlich & Spraul, 2007).

Characteristics of the Dialogical Tracks in the Wiki Discussion Section

Looking at characteristics that characterize the dialogical tracks in the wiki discussions section, the following seven aspects were found:

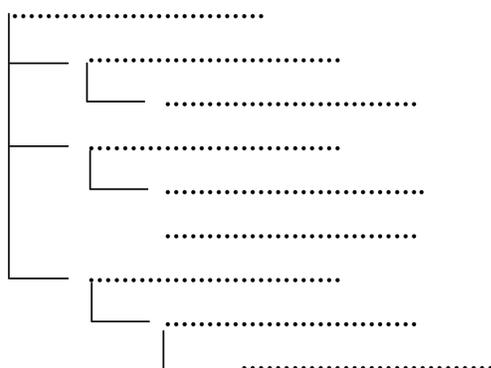
1. Number of participants.
2. Type of participants.
3. Types of dialogue contents.
4. Number of dialogue contents.
5. Number of messages.
6. Saturation of the dialogue.
7. Order of dialogic actions.

Let's discuss each of these aspects.

Number of Participants

The number of participants in a wiki track varied from one to five, but in most of these tracks 2-4 participants were involved, so the wiki enabled mostly two types of dialogical interaction: one-to-one interaction and a group interaction, where three participants or more participated in the group interaction. We shouldn't neglect extremes situations, where just one participant participated in the dialogical track or five participants participated. The first situation could have happened in one of three cases: (1) The participation was not noticed by any participant apart from this who wrote it (2) the participation didn't need further pursuing, for example it criticized something and corrected it (3) the participation needed pursuing but no participant pursued it. The third case could have happened for its relative unimportance to the other participants, or the other participants didn't know how to treat the issue that the participation described. The issues that attracted more participants involved issues related to pedagogic content knowledge. This could have happened because beliefs regarding pedagogic content knowledge may vary across teachers, but content knowledge

Figure 5. Topology of the electronic forum



should be the same if we consider the right content knowledge that teachers should own.

If we compare the ‘number of participants’ aspect in the wiki discussion section and the electronic forum (on mathematical content knowledge or pedagogic content knowledge), we find that the discussion in an electronic forum is generally one-to-one, while the discussion in a wiki environment could be a group discussion too. This finding can be explained by the different topologies of the two environments. The topology of the electronic

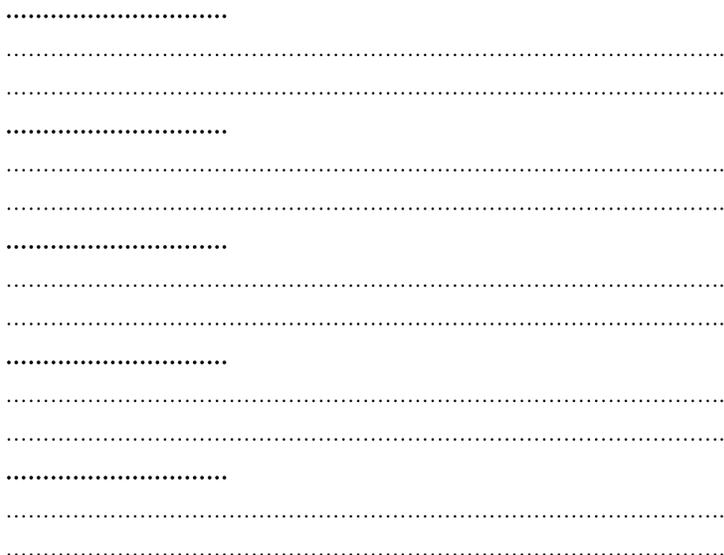
forum looks as in Figure 5 while the topology of the wiki discussion section looks as in Figure 6.

The participant who enters the electronic forum meets just the titles of the messages, while the participant who enters the wiki discussion section meets all the messages texts. This characteristic of the wiki discussion section would probably encourage this participant to read the messages and respond.

Type of Participants

Almost fifty percent of the wiki tracks were students-only. This suggests that discussions in the wiki environment could be totally held by students, and thus wiki discussions support students in building their knowledge independently. This claim is supported by Mason (1998) who says that discussion among students on specific topic has the potential to motivate inquiry and to create a learning context in which collaborative knowledge occurs.

Figure 6. Topology of the discussion section in the wiki



Types and Number of Dialogue Contents

Students and teacher used various dialogue contents to discuss and develop geometry content and pedagogical content knowledge. They inquired about these types of knowledge and requested improvement and development of the given texts. These inquiring and requesting caused the students and the teacher to suggest various dialogical actions and thus exchange and build geometric knowledge. The high percentage of suggesting actions wasn't triggered only by the requiring actions but by the other actions: accepting and notifying. What the high percentage of suggesting actions implies is that this type of actions is essential for students' knowledge building. The students learned by doing, by making mistakes and correcting (Mysliwiec, 2008).

More than half of the dialogical tracks had three to four dialogue contents. This implies the importance of the combination of dialogue contents to the construction of knowledge, here geometric content and pedagogic knowledge.

Saturation of the Dialogue Track

Two issues attract our attention here: third of the wiki tracks were saturated and more than third of them were semi saturated. These two facts point that more than two thirds of the wiki tracks had issues which were fully treated. The second fact, though, points that the participants didn't follow or utilize the discussion to treat all the relating issues that were raised. This could have happened because a participant felt or knew he/she presented a right answer, so why to bother and come back to find out if there was any new dialogical action related to his/her own?

Mason's (1998) found that the sharing of what participants knew through discussion helped to activate important thought processes. This happened in this research too; the students shared their knowledge regarding content and pedagogic

geometric knowledge to develop it and raise it to a new level (in the saturated tracks). This research's findings agree with the findings of Mason (1998) and Pontecorvo (1990, as reported by Black, 2005) that students' discussion has the potential to motivate inquiry and create learning contexts in which collaborative knowledge occurs. The findings also agree with Bauman (1997) who says that interactions between faculty and students motivate students to engage in tasks pedagogically and emotionally.

Order of Dialogic Actions

Some elements of the order of dialogic actions depend on the assignment required from the students; some elements depend on the dialogical action itself, while other elements depend on the students' preferences. The assignment required the students to discuss the geometric lessons in order to develop them. So, the students started the dialogical track by proposing how to do that or by rejecting or confronting some elements of the existing lesson. Some students started the track by asking about elements in the existing lesson. They probably did that as a preparation for proposing some development to the lesson or for presenting such development.

Some dialogical actions triggered specific actions, for example, proposing triggered mostly arguing, while asking triggered mostly presenting. These relations hold in a specific context, for example in a context of an assignment in a specific topic like developing geometric lessons.

Different students used different order of dialogical actions, for example some students preferred to start their participation by proposing to act in a specific way, others preferred first to reject or confront the existing material and then to propose, while some students preferred to ask first about the existing lesson and then to propose how to develop it. These preferences probably depended on two factors: the characteristics of the student and his/her confidence regarding the

geometric knowledge in question. If the student is confident he/she would probably propose how to develop the lesson, otherwise he/she would verify first regarding his/her doubts, and then propose. Characteristics determine if the student rejects a component of the lesson plan or proposes how to develop it without stating a rejection. This relation between the participants' characteristics and participants' behavior in the electronic forums is mentioned by ChanLin (2008) who points that learning and actions in online discussions is related to individual differences of students.

CONCLUSION

Teaching and learning geometry effectively can be accompanied by difficulties (Orrill, 2006). This research shows a successful way to learn about geometry and teaching geometry; the wiki discussions way. Preservice teachers who were required to develop pre-written geometry lessons used wiki discussions to build their own geometric content and pedagogic content knowledge. This was done in part by the preservice teachers alone and in part with the directing of the lecturer. Building their content and pedagogic content knowledge, the preservice teachers and lecturer used mainly the following dialogical actions: proposing, asking, requesting, arguing, presenting, and moving the discussion forward. Proposing and asking were used for various goals: to propose various ideas and actions, and ask about different issues concerned with geometric content and pedagogic content knowledge. The lecturer asked questions more than the preservice teachers, while the preservice teachers proposed more than the lecturer. The knowledge building was collaborative in nature, and one important aspect which enabled the collaboration is the topology of the wiki discussion section. This topology enables presenting the content of the messages; not just the titles, where the contents are presented as having the same level and thus the same importance.

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