Investigating Student Engagement in an Online Mathematics Course through Windows into Teaching and Learning

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Abstract

The Windows into Teaching and Learning (WiTL) project is a method developed by researchers at the University of North Carolina at Charlotte that allows the facilitation of online clinical experiences for students during their content area methods course. WiTL was developed to address difficulties in securing meaningful clinical placements for interns during online summer coursework. WiTL encompasses both an asynchronous and a synchronous component. Through the use of dialogue, the purpose of WiTL is to engage interns with practicing classroom teachers and with each other as they consider various teaching methodologies and observe these methodologies in practice. The authors describe the WiTL process, its implementation, and ways in which the process has encouraged various levels of student engagement in an online mathematics methods course. The results indicate varying levels of student engagement and suggest that students are more engaged during the asynchronous portion of this study.

Keywords: online content methods courses, student engagement, distance learning, asynchronous online learning, synchronous online learning, online clinical experiences

Introduction

Researchers at one southeastern University were experiencing difficulties with clinical placements during online summer coursework. During a summer school session, the challenge to find either year-round schools or schools that have a later end of year so that methods students can be placed in a classroom to observe teaching practices is problematic. In the past, students were allowed to observe the behavior of adolescents in other settings such as summer camps and the Young Men's Christian Association (YMCA). These observations did not provide an ideal situation in which students could observe classroom teachers in their content area delivering instruction. In an effort to deliver meaningful learning experiences and bridge the gap between theory and practice, Windows into Teaching and Learning (WiTL) was conceptualized and implemented. WiTL offered online clinical observation experiences of practicing teachers in various grades and content areas.

The WiTL process utilized web-conferencing software supported by the University. Students were required to have access to a computer, the Internet, a headset, and a webcam to participate in WiTL activities. Students in methods courses observed the practices of teachers both synchronously and asynchronously. Following synchronous classroom observations, which were delivered via Wimba, methods students were given the opportunity to debrief with the practicing teachers, using a text chat feature in Wimba. Dialogue was exchanged regarding the pedagogical practices of the teachers and the rationale for using particular methodologies. Methods students also participated asynchronously by watching prerecorded videos of the practicing teachers. Following these viewings, they participated in an online threaded discussion, via NiceNet, with each other and the practicing teachers.

This research explored the engagement of university graduate students in an online middle grades/secondary mathematics methods course during summer clinical experiences. Student–student interactions (Moore, 1989) were closely examined through an analysis of the asynchronous threaded discussions and synchronous text chat communications using the engagement framework devised by Perkins and Murphy (2006). The examination revealed various levels of engagement among students in both the synchronous and asynchronous platforms. The guiding research question for this study was: To what extent do students in an online mathematics methods course engage in meaningful discourse and collaboration that encourages them to critically examine teacher pedagogy?

Literature Review

Teacher education programs, through the use of technology, offer online courses that seek to enhance student learning (Nandi, Hamilton, Harland, & Warburton, 2011). Of the many technology-based modes of instruction used in online teacher education courses, online discussion forums are often specifically used as a vehicle for the continual discussion of class topics and concepts. In addition, this learning environment, whether synchronous or asynchronous, facilitates the dissemination and acquisition of knowledge and enables student interaction and collaboration (Levine, 2007). Transforming the traditional learning context, these pedagogical tools allow greater access to classroom peers as well as a fluid exchange of content and resources with the intent of improving learning outcomes.

Although online teacher education courses are an innovative and unique pedagogical approach, their effectiveness is often questioned because student interaction in online discussion forums does not necessarily mean that students are actively engaged in the learning process (McLoughlin & Mynard, 2009; Robinson & Hullinger, 2008). In fact, solely fulfilling the specified participation and time requirements of an online course suggests that students are merely "doing time" rather than "doing education" (Zyngier, 2007). In doing time, students fail to go beyond the content, do not bridge theory and practice, and avoid authentic student engagement. Considering that deep learners are often more engaged than surface learners (Hockings, Cooke, Yamashita, McGinty, & Bowl, 2008) and that pre-service teachers' pedagogical training will influence the lives of their future students, engagement is a poignant topic for online teacher education courses.

When reviewing the literature, we found that at the collegiate level the definitions and measurement of online student-to-student engagement were limited. However, the literature did show that engagement is seen through numerous lenses (Zepke & Leach, 2010): student motivation (Schuetz, 2008), students' social and economic background (Pascarella & Terenzini, 2005), institutional support (Kuh et al., 2005), peer interaction (Moran & Gonyea, 2003), teacher behavior (Bryson & Hand, 2007), etc. Although engagement is often difficult to define and measure in online courses, its absence and presence is identifiable. Due to the study's focus on student-to-student engagement, for the purpose of this study engagement is defined by Kuh (2003) as the efforts of the student to study a subject, practice, obtain feedback, analyze, and solve problems. This definition illustrates that engagement cannot be captured through a snapshot but rather has an interpersonal component. Engagement is best observed through interactions with others and through a development of complex ideas. For instance, echoing this definition of engagement, Guthrie and Anderson (1999) state, "social interaction patterns in the classroom can amplify or constrict students' ... attainment of deep conceptual knowledge" (p. 20). Furthermore, within the confines of face-to-face (F2F) schooling, engagement is seen as a multidimensional concept: behavioral, cognitive, and emotional (Fredricks, Blumenfeld, & Paris, 2004). Behavioral engagement measures students' ability to follow school rules, their level of involvement in learning, and participation in extracurricular activity; cognitive engagement is students' investment in and active participation in learning as they move beyond required coursework; and emotional engagement is the positive and negative feelings students hold for school. Aligning – yet moving beyond – the aforementioned definitions, engagement in this study is measured in the context of students' interactions in an online mathematics methods course. Engagement can be identified in this particular learning environment as participants meaningfully contribute to online discussions. Within the asynchronous and synchronous forums, students commented, asked for clarification, posed questions, made inferences, assessed the learning environment, and collectively strategized about how to best bridge content and pedagogy. Their interactions with each other are the focal point of analysis and determine whether student-to-student engagement was present within the online discussions.

One of the challenges of online discussion forums is determining whether quality online engagement is actually occurring or whether students are passively interacting with their peers. In an era where more and more students are learning via online coursework (Murray, Pérez, Geist, & Hedrick, 2012), it is imperative that researchers determine if online learning can equally promote student engagement in comparison to a F2F learning environment. If student engagement is absent or minimized, then full cognitive development in a specific content area is unachievable. Because of this uncertainty regarding online engagement and due to the need to move beyond rote memorization of knowledge, an evaluation of online learning engagement levels must be performed to ensure positive learning outcomes for online students.

Synchronous (occurring in real time) and asynchronous (occurring over time) online discussion forums provide a space for open communication among students. Regardless of person or location, one's thoughts are transmitted to others, constructing new knowledge or further developing existing ideas. While both modes of communication serve a common purpose, asynchronous communication is often deemed more appropriate for facilitating active, meaningful engagement. Recognizing weakness in both communicative resources, Branon and Essex (2001) outline the disadvantages of both types of communication that may consequently hinder student engagement. They list the following restrictions when utilizing synchronous communication: (1) getting students online at the same time; (2) difficulty in moderating large-scale conversations; and (3) lack of reflection time. Similar to synchronous discussions, asynchronous communication equally places limitations on engagement due to the lack of immediate feedback, and the infrequency of students logging in to online discussion forums.

Students' level of engagement during synchronous and asynchronous communication is often challenged because students are not physically present in the same space, supposedly decreasing their opportunity to socially interact, collaborate, give and receive feedback, and render support (Tuckman, 2007). Although both modes of communication possess certain weaknesses, traditional F2F student communication does not guarantee meaningful student-to-student engagement. In fact, bodies in close proximity to one another, occupying a shared classroom, may promote interaction but may fail to facilitate active, engaged learning. Unlike traditional F2F student communication, there are numerous synchronous and asynchronous modes of communication, which are used to promote engagement. The diverse asynchronous (e-mail, listserv, discussion boards, and web logs) and synchronous (chat, instant messaging, and audio and web-based conferencing) modes of communication have the potential to increase interaction and improve online learning environments (Repman, Zinskie, & Carlson, 2005). Through the implementation of effective pedagogical learning principles delivered via online communication, a community of engaged, communicative learners may emerge (Peck, 2012).

As mentioned, although constraints are present in both communication tools, Schellens, Van Keer, and Valcke (2005) affirm that asynchronous discussion boards foster active engagement through a community of learners who teach one another and provide constructive feedback while sharing and gaining information. Im and Lee (2003) advocate the use of asynchronous over synchronous in generating a more effective learning environment. PytlikZillig et al. (2011) also compare synchronous F2F discussions and asynchronous computer-mediated discussions, asserting that computer-mediated discussions produce more effective engagement than F2F discussions.

Moreover, the flexibility and convenience of time, which allows for greater reflection and more collaboration among students, is often cited as a primary reason for why asynchronous discussion forums are a preferred learning resource (Ajayi, 2009; Nandi, Hamilton, & Harland, 2012). While extended time does not necessarily equate to student engagement, the opportunity to engage with others is greater, increasing the likelihood that such engagement may occur. The presence of this engagement, though logical, requires further empirical support. The need for more research on engagement within online forums (Su, Bonk, Magjuka, Liu, & Lee, 2005) reiterates the persistent question of whether students are actively engaged or passively participating. In seeking insight in this matter, we begin with the following research problem: Are students fully engaged in online synchronous and asynchronous courses?

Adding to the literature, this exploratory study examines synchronous and asynchronous student–student interactions (Moore, 1989) in an online middle grades and secondary mathematics methods course for graduate education students. Students' levels of engagement were coded using Perkins and Murphy's (2006) engagement framework. Perkins and Murphy's rubric measures individual engagement in critical thinking in an online asynchronous discussion. While this model was previously used in online asynchronous discussions, answering Perkins and Murphy's call for further research, this study sought additional empirical data by applying their model to asynchronous and synchronous discussions. Perkins and Murphy's model was deemed appropriate and applicable to asynchronous and synchronous modes of communication because different levels of engagement, which were illustrated by students' varying levels of critical-thinking questions and comments, were present in both discussion forums. Identification and measurement of student engagement in critical thinking in both settings revealed that regardless of the online medium, the implementation of sound, student-centered pedagogical practices will foster student engagement. Table 1 provides a detailed classification of the four engagement categories.

Table 1. *Perkins and Murphy's (2006) model for identifying engagement in critical thinking*

Engagement Category	Indicators				
Clarification: All aspects of stating, clarifying, describing (but not explaining), or defining the issue being discussed.	Proposes an issue for debate.	Analyzes, negotiates, or discusses the meaning of the issue.	Identifies one or more underlying assumptions in a statement in the discussion.	Identifies relationships among the statements or assumptions.	Defines or criticizes the definition of relevant terms.
Assessment: Evaluating some aspect of the debate; making judgments on a situation, proposing evidence for an argument or for links with other issues.	Provides or asks for reasons that proffered evidence is valid.	Provides or asks for reasons that proffered evidence is relevant.	Specifies assessment criteria, such as the credibility of the source.	Makes a value judgment on the assessment criteria or a situation or topic.	Gives evidence for choice of assessment criteria.
Inference: Showing connections among ideas; drawing appropriate conclusions by deduction or induction, generalizing, explaining (but not describing), and hypothesizing.	Makes appropriate deductions.	Makes appropriate inferences.	Arrives at a conclusion.	Makes generalizations.	Deduces relationships among ideas.
Strategies: Proposing, discussing, or evaluating possible actions.	Takes action.	Describes possible actions.	Evaluates possible actions.	Predicts outcomes of proposed actions.	

Method

Project Description and Participants

The primary goal of WiTL was to provide a meaningful summer clinical experience for students enrolled in an online mathematics methods course. Data were collected from all students (n = 22) enrolled in the online summer mathematics methods course at the researchers' University. Researchers utilized a middle school and a high school based on faculty connections in working within the school and community. The three teachers of middle grades that were invited to participate in this project were identified by their principal as exemplary teachers. All three middle grade levels were represented: one teacher was a sixth-grade mathematics teacher, one a seventh-grade mathematics teacher, and one an eighth-grade mathematics teacher. The three high school teachers that were asked to join were also acknowledged by their principal as exemplary teachers. The three teachers collectively taught *Algebra I*, *Algebra II*, *Geometry*, *Pre-Calculus*, and *Advanced Placement Calculus*. Prior to the beginning of the summer methods course, each of the practicing teachers selected two exceptional lessons. These lessons were then videotaped during regular classroom instruction using a laptop, wireless headset, webcam, and TechSmith's Camtasia, a software application used for screen video capture.

The methods students viewed these 12 asynchronous videos (two per teacher) and then participated in an online dialogue regarding the practices they observed. These threaded discussions, facilitated through

NiceNet, occurred over two weeks and allowed methods students to engage in conversation with the six practicing mathematics teachers and their peers. The conversations (examples provided in data analysis section) included dialogue between students regarding instructional methods and pedagogical thinking concerning the teaching and learning of mathematics for Grades 6 to 12.

The three middle school and three high school mathematics teachers were also asked to allow online mathematics methods students to participate in a live teaching observation. These synchronous teaching observations were facilitated using a computer connected to the Internet, a webcam, a wireless headset, and Saba Centra (the University-supported web conferencing software). These items were chosen because all online cohort students utilize these technological tools throughout their program coursework. Methods students logged on to Centra at the indicated class time to observe the teachers. They viewed six separate teaching episodes and participated in a text chat dialogue with their classmates during the observations. This viewing and interaction allowed students to ask one another questions regarding the classroom environment, classroom management, instructional methods, and pedagogical thinking.

Following the teaching observation, the classroom teacher joined the methods students in Centra to take comments about their teaching and answer questions regarding instructional decision making. Examples are provided in the Data Analysis section.

WiTL was a multifaceted project, and therefore, generated several data sources. These included individual interviews with each classroom mathematics teacher, focus group interviews with methods students at the conclusion of the semester, copies of the asynchronous threaded discussion forum, text chat logs of methods students conversations during the synchronous teaching observations, and archives of both the synchronous and asynchronous sessions. The data essential to this present study are the asynchronous threaded discussions, facilitated through NiceNet, and the text chat logs, facilitated during the synchronous teaching observations via Centra. The following research question guided the analysis of data:

> *To what extent do students in an online mathematics methods course engage in meaningful discourse and collaboration that encourage them to critically examine teacher pedagogy?*

Data Analysis

The threaded discussions were analyzed to determine various levels of student-to-student engagement during online clinical experiences. Researchers used content analysis to quantify levels of engagement based on students' questions and comments in the threaded discussions. Students' levels of engagement with each other were coded using Perkins and Murphy's (2006) engagement framework presented in Table 1. Various levels of analysis occurred. Initially, the researchers evaluated the data independently, determining which level of engagement was represented in the dialogue. Next, the researchers compared their analyses and determined inconsistencies. Finally, inconsistencies were discussed until final consensus was reached. This method of analysis allowed the researchers to establish inter-rater reliability (Neuendorf, 2002). Frequencies for each category were then tabulated.

The text chat logs, generated during the synchronous teaching observations, were analyzed in a similar manner using content analysis. Again, students' levels of engagement with each other were coded using Perkins and Murphy's (2006) engagement framework (see Table 1). Researchers conducted an independent analysis of the data to decide which level of engagement was represented in the various comments and questions stated during text chat sessions. Researchers then compared their analyses to determine inconsistencies. Once more, inconsistencies were debated until consensus was reached, allowing for the establishment of intercoder reliability (Neuendorf, 2002). Frequencies for each category were then recorded.

Results

After the threaded discussions and text chat logs were analyzed, relative frequencies were tabulated. These data are presented in Table 2.

The data, although not conclusive, indicate varying levels of student engagement across both synchronous and asynchronous platforms. This distribution of student outputs across the engagement categories yields interesting results. The asynchronous forum postings show a higher percentage of Strategy engagement (15.2% vs. 7.9%) as well as a higher percentage of Clarification engagement (61% vs. 45.7%). The synchronous forum postings indicate something different. The categories of Assessment

(35.3% vs. 17.5 %) and Inference (11.1% vs. 6.3%) indicate higher levels of engagement for the synchronous platform.

Table 2. *Frequency of student output – synchronous vs. asynchronous*

Engagement Category	Asynchronous (Threaded Discussion)	Synchronous (Text Chat Logs)
Clarification	61.0%	45.7%
Assessment	17.5%	35.3%
Inference	6.3%	11.1%
Strategies	15.2%	7.9%

It is important to note that the threaded discussion forum was available to students and classroom teachers for two weeks, while the text chat logs were offered during six synchronous teaching observations with durations of 75 to 90 minutes each. All four categories of engagement were observed in both the threaded discussions and text chat logs. Students in both settings engaged more at the level of clarification. This was apparent as students asked questions and made comments regarding the classroom context (i.e., configuration of the desks/classroom, decoration of the classroom, technology available to students, academic levels of students, etc.). As the level of engagement increased on Perkins and Murphy's (2006) engagement framework, the relative frequency of students' comments and questions decreased with the exception of the Strategies category. This could be warranted due to the time required for students to reflect on teachers' actions and offer possible justifications. All four categories were observed, but as noted above, engagement cannot be solely measured by frequency (doing time). A critical examination of the actual content presented by students during the threaded discussions and text chat dialogues must also be considered when determining students' engagement level.

The data presents examples of authentic student engagement. For example, the following are distinct comments and statements posted by one student and responded to by another student during the asynchronous online discussion forum (NiceNet). In this exchange students share questions they still have about slope and direct variation and suggestions for teaching systems of equations. This exchange reinforces the notion that students can learn important teaching strategies from one another when they have the opportunity to discuss their ideas. The level of engagement based on Perkins and Murphy's (2006) framework is indicated [in brackets, and rendered in **bold**].

> Student 1: *"I really like how you* [the teacher] *make the association between slope and direct variation because that is a topic that my ninth-grade Algebra I students have a hard time with. Do you have any other suggestions on how to make it clearer?* **[Strategies]** *Also why did they change the variable to "k" instead of leaving it as "m"?* **[Clarification]** *I am a math major (not an education major) and I still am not sure why the variables in direct variation and slope intercept changed. I know it is a little late in the year for this stuff and you may have done this before, but there is a cool activity to do with solving systems. You break the students in groups and have them do an advertisement for a particular method. I make my students show examples, write a definition, make a logo, a slogan and a valid argument as to why their method is better than all the others. I also make them present it in front of the class. They usually have fun with it.* **[Strategies]***"*
>
> Student 2: *"I am also a math major and have never understood why the variable changed. I look forward to the teacher's answer!* **[Clarification]** *Also, thanks for sharing that method! Systems of equations was the topic I struggled the most with teaching this year and am concentrating on to make it better for next year. I love your project idea and am definitely going to implement that into my classroom!* **[Assessment]***"*

The exchange below is also taken from the NiceNet threaded discussion. It exemplifies quality engagement during student-to-student interaction. The students really push each other to think about the topic of fractions and consider various situations in which fractions are used. Both students are making connections, providing examples, going beyond the content, and actively contributing to the discussion.

> Student 3: *"When in real life do we ever really use fractions? I can think of obvious ones: slices of pizza, talking about discounts and sales tax, but other than those, I'm not sure I really know if we DO use fractions.* **[Assessment]***"*
>
> Student 4: *"I would argue that we use fractions every time we have to use division. If you look at a class and want to know what percentage of the students did their homework, you are going to have to collect the raw data first. If 16 out of 20 students did their homework, that is a fraction, 16/20. After you know that fraction, you are able divide and determine what that number is as a decimal and percentage. I agree that numbers are not usually left as fractions, and that fractions do not always look as polished as decimals do, but they are something that is used in many people's daily lives.* **[Assessment]***"*
>
> Student 3: *"Thank you for pushing my thinking. However, if we are using a fraction to solve for a percent on a test, wouldn't we convert it to a decimal to understand it better? Maybe it is the way I think and not the way the world works, but I understand 80% much better than I understand 16/20 even though they represent the same amount. Also, will we ever have to multiply, divide, add, or subtract fractions in real life? I absolutely agree that students need to be able to convert fractions to decimals to percents and vice versa, but will it hurt them to use a calculator to always compute with fractions (as in adding, subtracting, multiplying, and dividing)? I am not sure I know the answer to that question ...* **[Assessment]***"*

The following are individual comments made by students to students during the synchronous teaching observations via the text chat feature in Centra. In this exchange, students are discussing the note taking methods used by the teacher they are observing. This exchange reveals the ideas that the students have regarding this technique. The level of engagement based on Perkins and Murphy's (2006) framework is indicated.

> Student 1: *"How structured do you think note taking should be? Right now, they're basically writing exactly what he dictates.* **[Clarification]***"*
>
> Student 2: *"I think it will depend on my students ... may have to feel it out ...* **[Assessment]***"*
>
> Student 3: *"I think that note taking is a skill that has to be explicitly taught.* **[Assessment]***"*
>
> Student 4: *"I agree that it has to be taught, but you can't learn if you always are just copying something ...* **[Assessment]** *Maybe this is a good method for younger students who are still in the beginning stages, though.* **[Inference]***"*

The exchange below is also taken from the text chat log. During this exchange, students are observing a teacher-centered classroom. The teacher is initiating traditional instructional methods. The students are offering suggestions for getting the middle school students motivated as many of them are visibly disengaged.

> Student 1: *"Maybe some cooperative learning activities and more game type learning would motivate them a little more. Make the students think they're playing instead of learning.* **[Strategies]***"*
>
> Student 2: *"They will think it is a reward for passing the test.* **[Strategies]***"*
>
> Student 3: *"The teacher should consider maybe not teaching new information but readdressing what they did not get.* **[Strategies]***"*

The comments/questions presented above demonstrate the various levels of engagement that students exhibited as they participated in both the threaded discussions and the text chat dialogues. Students discuss a variety of issues that they see as they observe teaching practices via synchronous and asynchronous observations.

Limitations

As with most research studies, this study does have its limitations. The most apparent limitation is the small sample size, making the results difficult to generalize. The study was conducted over a short period of time – one semester during the summer. In the course of this study, there were technical difficulties. During two of the synchronous teaching observations, the teachers had difficulty with their wireless headsets, which resulted in periods of no sound for the online methods students who were viewing the teaching observations. This issue was quickly resolved. Another possible limitation relates to the asynchronous threaded discussion. Since this is a monitored forum, students may have felt more inclined to participate and to provide thoughtful responses.

The use of the Perkins and Murphy (2006) framework could also be viewed as a limitation. It was first developed for use with the asynchronous platform. This study took it a step further and utilized it with both asynchronous and synchronous platforms.

Conclusion

In this study, the researchers explored the guiding research question: To what extent do students in an online mathematics methods course engage in meaningful discourse and collaboration that encourage them to critically examine teacher pedagogy? It was determined that students engage in all levels of engagement as defined by Perkins and Murphy (2006) in both asynchronous and synchronous platforms. While asynchronous forum postings show a higher percentage of Strategy engagement (15.2% vs. 7.9%) as well as a higher percentage of Clarification engagement (61% vs. 45.7%), the synchronous forum postings indicate something different. The categories of Assessment engagement (35.3% vs. 17.5 %) and Inference engagement (11.1% vs. 6.3%) presented higher levels of engagement for the synchronous platform. The settings of the individual platforms would certainly encourage this. In the asynchronous environment, students would have more time to reflect and therefore offer strategies. Clarification engagement may be more present in the asynchronous platform because students in the synchronous platform were afforded opportunities to get clarification to these questions during the synchronous settings that were not readily available in the asynchronous setting. This notable constraint does differ from the literature, which asserts that asynchronous is preferable. The results of the WiTL study suggest that the asynchronous and synchronous platforms are emphasizing different types of engagement. Future research studies are needed to determine which method is more beneficial, or if one method is better at engaging students in an online environment.

WiTL proved to be a beneficial experience for methods students. It offered outreach to students across the state through an innovative approach to clinical experiences. WiTL provided the online methods students not only the opportunity to view sound teaching practices, it also allowed them the chance to engage with practicing mathematics teachers to confirm their understandings of methodologies and pedagogical decision making. During a typical clinical observation experience, a student would be placed with one teacher and one classroom. In this online mathematics methods course, students were placed in different classrooms across a variety of schools. WiTL was a unique experience in that it allowed online methods students to observe six different teachers in two different schools and school systems, exposing them to an assortment of teaching styles in a variety of classroom environments. Since WiTL allowed the online methods students to observe the same teachers, an exchange of thoughts and ideas related to the instructional strategies they observed was also facilitated. The WiTL process was equally valuable to the practicing mathematics teachers as it allowed them the opportunity to critically reflect on their teaching practices as they considered questions that the methods students posed. Through WiTL, methods students were able to utilize technology to engage in online clinical experiences at various levels with their peers.

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