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Future Teachers' Dispositions Toward Teaching With Geospatial Technologies

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Abstract

This study examined the effect of a minimal Web-based GIS experience within a semester-long methods course on enhancing preservice teachers' dispositions regarding the use of geospatial technologies for teaching. Fourteen preservice teachers enrolled in a senior-level methods course offered in geography and focused exclusively on how to teach geography in K-12 classrooms participated in the study. The findings of the study indicate that Web-based GIS activities had a positive impact on participants' beliefs, attitudes, and confidence in GST implementation and teaching spatial thinking in their future classrooms.

Professional development for teachers to teach with geospatial technologies (GST) is crucial to successful implementation of GST into classrooms (Baker et al., 2015), and its importance has been emphasized since the implementation of the *National Geography Standards* (Geography Education Standards Project, 1994). The role of GST in geography education has become more explicit in the revision of Geography Standard 1, "How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information" (Heffron & Downs, 2012, p. 21), reflecting the development of GST and increased recognition of spatial thinking as a key practice in geography (Bednarz, 2015).

Learning to teach with GST is crucial for preservice teachers to be able to fully implement the knowledge, skills, and practices of geography featured in the standards (Bednarz & Audet, 1999). However, the implementation of GST in teacher preparation and relevant research to facilitate this process are still insufficient.

Much of the literature on teacher preparation for successful integration of technology into classrooms has focused on enhancing technological, pedagogical, and content knowledge (Clark, Zhang, & Strudler, 2015; Mishra & Koehler, 2006), and slow and ineffective technology implementation has often been attributed to a lack thereof. However, studies also have identified a positive relationship between teachers' personal beliefs and dispositions and their classroom integration of technology (Becker, 2000; Conderman & Walker, 2015; Ertmer, 2005; MacArthur & Malouf, 1991; Saye, 1998; Smith, Moyer, & Schugar, 2011; Vannatta & Fordham, 2004).

Heo (2011), for example, recognized dispositions toward changes in new technologies for teaching as one of the "internal barriers" that preservice teachers should overcome to incorporate the technology successfully in their classrooms. Therefore, effective implementation of innovative technologies, like GST, in education will require preparing teachers to develop not only the necessary knowledge and skills for but also positive dispositions toward using GST as a tool for teaching.

Few studies have examined how to prepare teachers as instructional gatekeepers to implement GST in the classroom (Jo & Bednarz, 2014). Little is known about characteristics of learning experiences that can promote preservice teachers' dispositions toward teaching with GST. Thus, the purpose of this study was to address the research gap by examining the effect of Web-based GIS experiences within a semester-long methods course on enhancing dispositions toward GST for teaching.

Background

Role of Dispositions in Teachers' Technology Integration

Successful integration of technology for teaching and learning requires much more than simply putting technology into a classroom. Studies suggest common implementation problems, including limited access to hardware and software, insufficient resources, lack of appropriate training, and constraints on time for planning (MacArthur & Malouf, 1991; Saye, 1998). According to Heo (2011), teachers must overcome not only those external barriers but also the "internal barriers dealing with organizational culture and pedagogy such as teachers' attitudes, beliefs, practices, and resistance toward educational technology" (p. 62). When teachers lack adequate knowledge and information, beliefs and attitudes play an even more significant role in their decision making (Saye, 1998).

In addition, technology itself is not a pedagogical strategy but rather a versatile tool that can be used in many different ways to meet various goals in education. Therefore, the ways teachers use technology may greatly differ from one another. MacArthur (1991) argued that teachers' technology use depends largely on their overall educational goals, their classroom routines, and their specific knowledge and beliefs about the benefit of technology. Smith et al. (2011) also pointed out that teachers' effective integration of technology reflects and correlates with their personal beliefs and dispositions about whether the integration of technology would support both student learning and their professional goals.

Empirical evidence has been presented to support the importance of dispositions in teacher technology use. For example, Marcinkiewicz (1993) examined the degree to which various personal characteristics of teachers predict the level of their computer uses in the classroom. Among the variables, including age, gender, years of computer experience, perceived relevance of computers to teaching, locus of control, perceived competence, and innovativeness, two variables—self competence in the use of computers and willingness to change to adopt innovations—were most closely related to teachers' levels of computer use.

Vannatta and Fordham (2004) conducted a similar study and examined the relationship between a variety of teacher variables—amount of professional development, amount of technology training, years of teaching, self-efficacy, and philosophy—and their technology use for teaching. A regression analysis revealed two dispositional characteristics—openness to change and willingness to commit time—as the best predictors of classroom use of technology.

A study by Baylor and Ritchie (2002) also showed that teachers' openness to change is highly correlated to not only their technology integration level but also to their competency using technology and student practice of higher order thinking through technology-integrated lessons:

Teachers who are open to change, whether this change is imposed by administrators or as a result of self-exploration, appear to easily adopt technologies to help students learn content and increase their higher-level thinking skills. It also appears that as these teachers incorporate these technologies, their own level of technical competence increases, as does their morale. (p. 412)

Empirical evidence is lacking about the effect of teacher dispositions on the uses of GST in the classroom, although researchers have emphasized willingness among teachers to learn more about and undertake an intellectual endeavor for teaching with GST as one of the key factors to achieve successful integration of GST in education (Coulter, 2014). According to Coulter several specific teacher characteristics determine their ability to teach with GST, including in-depth knowledge about the topics, confidence in data-informed, model-based reasoning, ability to guide student inquiry, and curiosity and passion for further learning.

The first three characteristics correspond to the already well-known technology, pedagogy, and content knowledge framework (Mishra & Koehler, 2006. The last attribute—curiosity and passion to learn more—is related more to teacher disposition than knowledge or skills. Coulter (2014) stressed that all these teacher characteristics are equally important as teacher geospatial "capacity factors" (p. 289). Teacher preparation programs must consider disposition as one of the key elements for teachers to build their competence in teaching with GST.

Strategies to Enhance Dispositions Toward Teaching With Technology

The state of the literature leaves the question of how to enhance teacher dispositions related to teaching with GST largely unanswered. At a minimum, teacher education programs can prepare preservice teachers to integrate GST through the educational technology component of the curriculum (Baker et al, 2015). Regarding the development of positive dispositions, teacher education research suggests several key strategies, including exposure, technology-integrated methods courses, and teacher educator modeling and reflection.

In an extensive review of literature focusing on introducing technology to preservice teachers, Kay (2006) found that a number of studies emphasized the importance of the teacher education faculty members themselves using technology to expose preservice teachers to the power of technology as a learning tool (Alexander, Knezek, Christensen, Tyler-Wood, & Bull, 2014; Vannatta & Fordham 2004).

If teacher education faculties adopt technology in their teaching practices, preservice teachers are more likely to be motivated in this endeavor (Kay, 2006). Exposing preservice teachers to technology-integrated learning environments is an effective strategy to introduce technology and model technology use in education. It is also a necessary first step to enhance preservice teachers' dispositions toward technology use in classrooms (Clark et al., 2015).

However, mere exposure will not be adequate in moving preservice teachers to decide to use technology or enabling them to integrate it into their future classrooms effectively. They need training "not just about technology but through technology, in courses that focused on other contexts (not in technology courses)" (Smith et al., 2011, p. 2). According to Stetson and Begwell (1999), effective integration of technology into teacher preparation relies largely on integration of it into methods courses. Pope et al.'s (2002, 2005) and other studies (Wang & Holthaus, 1999) showed that completion of standalone technology courses have little to do with preservice teachers' ability to apply the technology in real classroom settings.

In order to develop dispositions and confidence in using technology in classrooms, preservice teachers need to learn how to integrate technology by exposure to numerous demonstrations of effective technology-enhanced lessons (Groth, Dunlap, & Kidd, 2007; Vannatta & Fordham, 2004). Methods courses must also provide preservice teachers with opportunities to reflect on their beliefs and dispositions toward technology use and its effect on student learning (Vannata & Fordham, 2004). Researchers have found that dispositions are influenced by teacher educators who model technology integration and risk-taking behaviors needed to adopt innovations (Kay, 2006; Vannatta & Fordham, 2004).

Web-Based GIS Activities in a Method Course

Informed by the strategies proven in the literature to be helpful, a set of Web-based GIS activities were developed and infused into a semester-long methods course for social studies preservice teachers. The specific objectives were to (a) expose preservice teachers to a GST-integrated learning environment, (b) help them learn through GST in a methods course, and (c) provide a model of reflective and critical adoption of technology to the classroom. Table 1 summarizes the topics, types, and objectives of the Web-based GIS activities implemented in the course.

The primary focus of the exposure activities (Activities 1 and 2) was to enhance preservice teachers' awareness and understanding of the potential of GIS as a tool for teaching and learning. Research suggests that GIS offers teachers opportunities to engage students in spatial thinking and sophisticated geographic inquiry (Kerski, 2008; Liu & Zhu 2008; National Research Council, 2006), which are two important goals in geography education. Students read articles and watched video clips exemplifying the close relationship that uses of GIS have with spatial thinking and geographic inquiry and participated in a guided discussion.

Table 1
Summary of Web-based GIS in Geography Education Activities

Activity	Topic/Focus	Type	Objective
1	Geographic inquiry Geospatial revolution	· Reading · Watching videos · Discussion	· Exposure
2	The importance of spatial thinking What is GIS? GIS for spatial thinking education	· Reading · Watching videos · Discussion · Reflection	· Exposure
3	Getting to know ArcGIS Online	· Hands-on · Reflection	· Exposure · Learning through GST
4	Learning geographic inquiry with AGO (1): A physical geography example	· Hands-on · Reflection	· Learning through GST · Modeling
5	Learning geographic inquiry with AGO (2): A human geography example	· Hands-on · Reflection	· Learning through GST · Modeling
6	AGO Story Maps for teaching	· Watching videos · Hands-on	· Exposure · Learning through GST
7	Teaching social studies with AGO	· Reading · Developing a lesson outline	· Learning through GST

Activity 3 was dedicated to several simple exercises to familiarize preservice teachers with basic features of ArcGIS Online (AGO), a Web-based GIS application, so that they became comfortable using it for the rest of the semester. A modified version of *ArcGIS Online Five by Five* (available at https://esri.app.box.com/ago5x5) developed by the Esri Education Team, was used. Preservice teachers were engaged in simple but important geographic investigations and problem solving exercises. In Activities 4 and 5, preservice teachers examined two geography lesson examples that use AGO to facilitate students' geographic inquiry and spatial thinking. Adapted versions of "Investigating Temperature Extremes in the USA Using ArcGIS Online" (http://edcommunity.esri.com/resources/arclessons/lessons/e/extreme_temperatures_in_usa_in) and "Analyzing Demographic Components and Their Implications on Society" (http://edcommunity.esri.com/resources/arclessons/lessons/a/analyzing_demographic_componen), developed by Joseph Kerski, were used both to help preservice teachers enhance their content knowledge about the topics and to demonstrate how GIS can be used to guide students' inquiry.

Activity 6 introduced AGO Story Maps and Activity 7 required preservice teachers to examine the state's social studies standards, identify one or two learning objectives, and develop an outline of a lesson in which using GIS could effectively help students achieve the learning objectives. Students completed the activities as weekly assignments, and the instructor (i.e., the researcher/author) provided feedback by writing comments to individual students and by debriefing the whole class.

The uses of GIS in this course as a whole were minimal, and the level of activities were basic. First, the course was neither an educational technology course nor a geospatial technology course. It is a senior-level methods course offered in geography but served both geography majors and education majors who were seeking a certificate for teaching geography or social studies. Most students had little to no experience in GIS.

The amount of geography coursework of those majoring in education is also very limited. Therefore, minimal-GIS in the context of teaching geography was most appropriate, considering the characteristics of the audience. In addition, GIS, in this context, was one of many tools and strategies for teaching. Ensuring balance among different areas and foci in teaching was considered more important than devoting most class time to dealing with GIS applications.

Research Questions

The following two research questions guided this study:

- How did the minimal Web-based GIS experience influence preservice teachers' dispositions toward teaching with GST in the classroom?
- How did the minimal Web-based GIS experience impact their awareness and beliefs about teaching spatial thinking?

Methods

Participants

Fourteen preservice teachers enrolled in a senior-level methods course offered in geography and focused exclusively on how to teach geography in K-12 classrooms participated in the study. This course is mandatory for geography majors seeking a teaching certificate and one of the highly enrolled courses by education majors whose emphasis is on middle and secondary social studies. The course is offered every semester, and the average number of students each semester ranges from 15 to 25. The participants of this study consist of 10 females and four males. Two were geography majors, and the others were education majors. None of them had GIS or other GST-related course experience, although the geography majors possessed basic awareness of GIS.

Data Collection and Analysis

Both quantitative and qualitative methods were used to collect and analyze data on participants' dispositions toward using GST in their future classrooms. Pre- and postsurveys administered at the beginning and end of the semester constituted quantitative data. The survey questionnaire included eight items to assess preservice teachers' beliefs, attitudes, and dispositions related to (a) the uses of GST in the classroom and (b) education of spatial thinking. The questions were extracted from the Teaching Spatial Thinking through Geography Disposition Inventory, which has 40 items across five item categories: Teaching thinking skills, teaching spatial thinking, spatial thinking in geography, explicit teaching of spatial concepts, and adopting spatial representations and geospatial technologies (Jo & Bednarz, 2014). Reliability and validity of the instrument have not yet been established, but this is the only available instrument in the literature to assess teacher disposition related to teaching spatial thinking.

The dispositional characteristics the inventory intended to assess are much broader in scope than those of the present study. Therefore, only eight questions considered to be closely related to the dispositions of using GST were selected for inclusion in this study (see Appendix). Items 1 through 4 assess preservice teachers' beliefs about, self-confidence in, and willingness to use GST in their future classrooms, whereas Items 5 through 8 are related more to their awareness of and beliefs about teaching spatial thinking in schools.

Each participant's disposition score was calculated as a sum of the responses to the eight items (1 = *strongly disagree*; 5 = *strongly agree*). Mean scores were then calculated across the pre- and postsurvey administrations by item as well as by category and analyzed using a paired samples *t*-test.

Qualitative data were collected through participant reflections on activities completed throughout the semester. The guiding questions for reflection and the data used for analysis are presented in Table 2.

Table 2
Guiding Questions for Reflection

Activity	Topic	Guiding Question for Reflection
2	The importance of spatial thinking What is GIS? GIS for spatial thinking education	What would be potential of using GIS to facilitate geographic and/or spatial thinking?
3	Getting to know ArcGIS Online	How do you feel about basic features of AGO? What did you like or dislike?
4	Learning geographic inquiry with AGO (1): A physical geography example	What would be benefits of using GIS in this physical geography lesson for students to achieve the learning objectives?
5	Learning geographic inquiry with AGO (2): A human geography example	What would be benefits of using GIS in this human geography lesson for students to achieve the learning objectives?

Results

Analysis of Pre and Post Disposition Surveys

The results show an increase in disposition scores from pre- (3.580, *SD* = 0.499) to postsurvey (4.705, *SD* = 0.276) of 1.125 (95% CI = 0.807–1.443), and a paired samples *t*-test revealed that the mean difference was statistically significant ($t = 7.649$; $p < .001$). (See Table 3.) Average disposition score changes were analyzed also by item category. Table 3 shows average scores increased for both categories on the postsurvey, and a slightly greater increase was observed in the spatial thinking category (1.173, 95% CI = 0.793-1.564) than in the GST category (1.071, 95% CI = 0.698-1.445).

Table 3
Disposition Score Changes Between Pre- and Postsurveys

Item	Presurvey		Postsurvey		Post – Pre					
									CI (95%)	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SE***	***t***	***P***	**Lower**	**Upper**
Item 1	4.214	0.802	4.929	0.267	0.714	0.194	3.680	.003	0.295	1.134
Item 2	4.000	0.679	4.929	0.267	0.929	0.165	5.643	.000	0.573	1.284
Item 3	2.929	0.997	4.571	0.514	1.643	0.325	5.056	.000	0.941	2.345
Item 4	3.857	0.663	4.857	0.363	1.000	0.182	5.508	.000	0.608	1.392
GST Subtotal	3.750	0.679	4.821	0.228	1.071	0.173	6.204	.000	0.698	1.445
Item 5	3.000	0.784	4.500	0.760	1.286	0.194	6.624	.000	0.866	1.705
Item 6	3.500	0.650	4.643	0.497	0.786	0.214	3.667	.003	0.323	1.249
Item 7	3.643	0.633	4.429	0.514	1.143	0.206	5.551	.000	0.698	1.588
Item 8	3.500	0.519	4.786	0.426	1.500	0.327	4.583	.001	0.793	2.207
ST Subtotal	3.410	0.515	4.589	0.362	1.173	0.179	6.600	.000	0.793	1.564
Total	3.580	0.499	4.705	0.276	1.125	0.147	7.649	.000	0.807	1.443

Table 3 also presents item level changes in the mean disposition scores, but the results were visualized for easy comparisons (Figure 1 and Figure 2). Score changes were smaller for Item 1. This result can be ascribed to a ceiling effect in which the presurvey score was already high (4.21). The largest mean increase (from 2.93 to 4.57) was observed on Item 3.

In the spatial thinking category, two items showed a large increase on the postsurvey: Item 5 (from 3.00 to 4.50) and Item 8 (from 3.50 to 4.79).

Analysis of Participants' Written Responses

Discourse analysis offers a means to a systematic analysis of written text, and analysis of written text of students is often useful to assess their "prior knowledge, beliefs, and feelings" (Goldman & Wiley, 2011, p. 121). In this study, participants' written responses to guiding questions during some of the Web-based GIS activities were collected and analyzed using a discourse analytic approach. In order to identify dispositional characteristics suggested in the participants' written statements, I looked for words, phrases, or statements that reflect participants' beliefs, feelings, thoughts, or dispositions. For each of the guiding questions, the disposition-indicating words, phrases, or statements were grouped to form categories of salient features of dispositions toward the use of GIS for teaching. Total numbers of disposition-indicating comments on each question and percentages by category are shown in Figure 4.

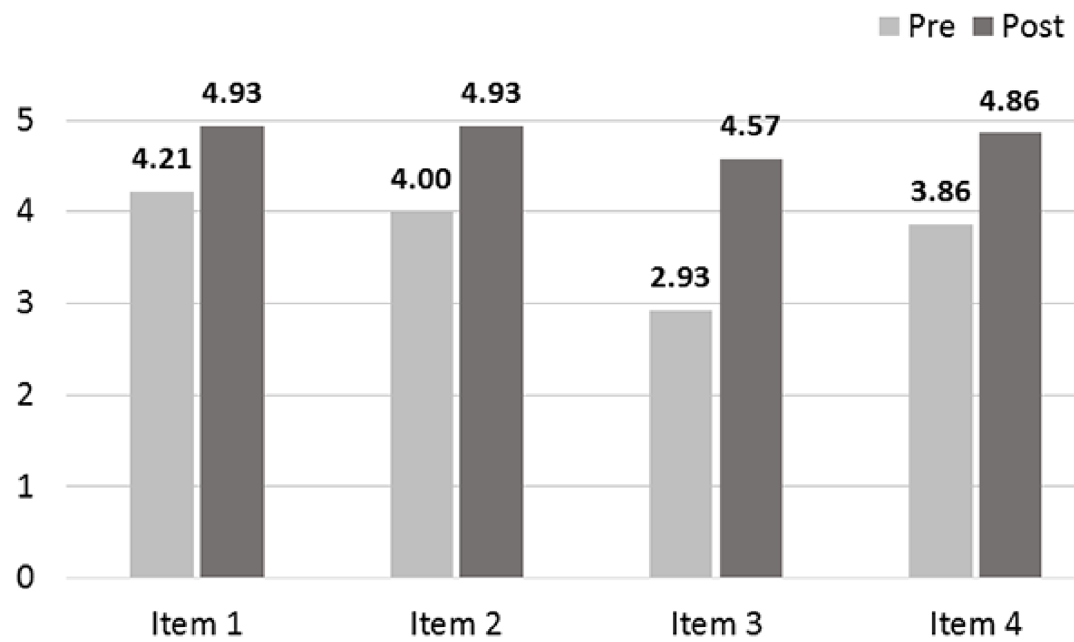

Figure 1. *Pre and post disposition scores: Use of GST category.*

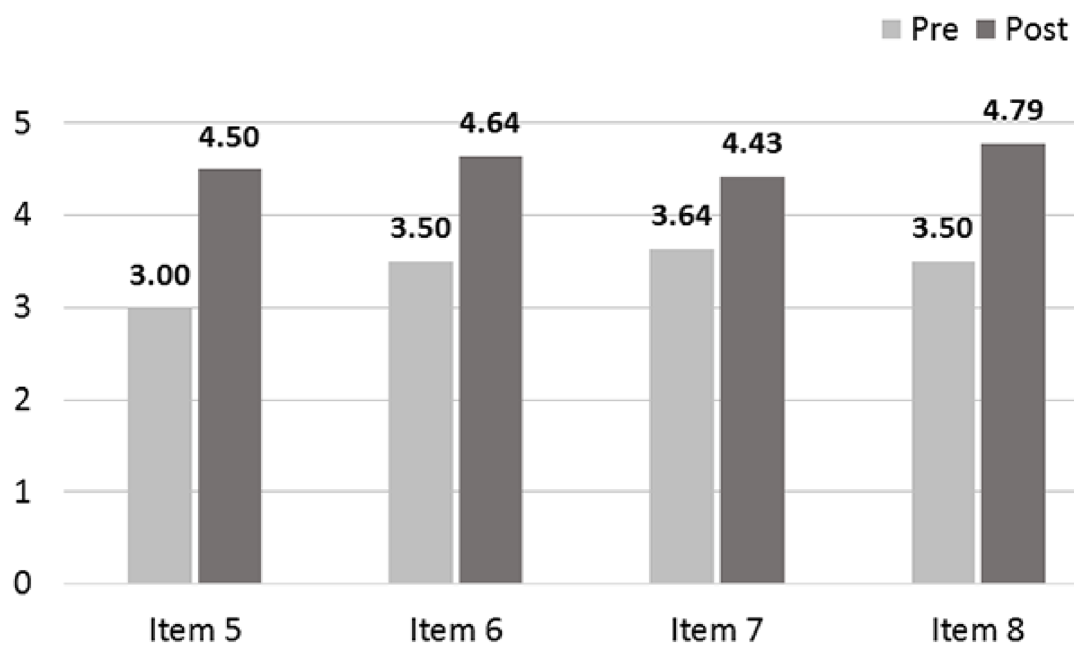

Figure 2. *Pre and post disposition scores: Teaching spatial thinking category.*

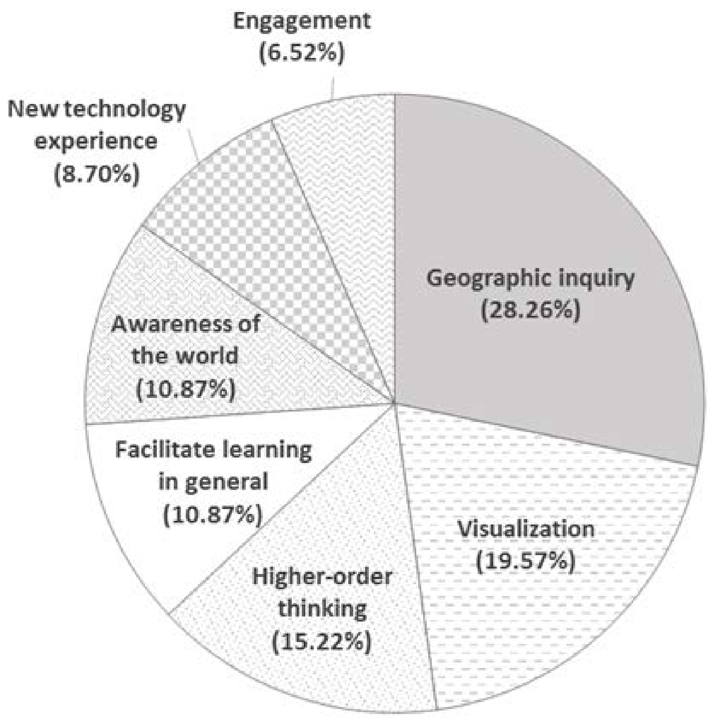

Figure 4a. *Categories of responses to "What would be potential of using GIS to facilitate geographic and/or spatial thinking? (*n *= 46).*

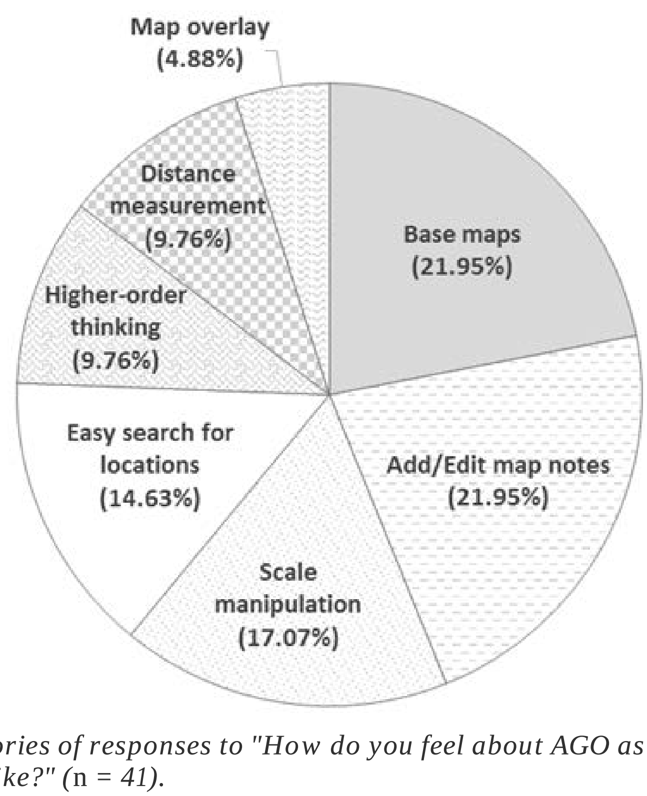

Figure 4b. *Categories of responses to "How do you feel about AGO as a tool? What did you like or dislike?" (*n *= 41).*

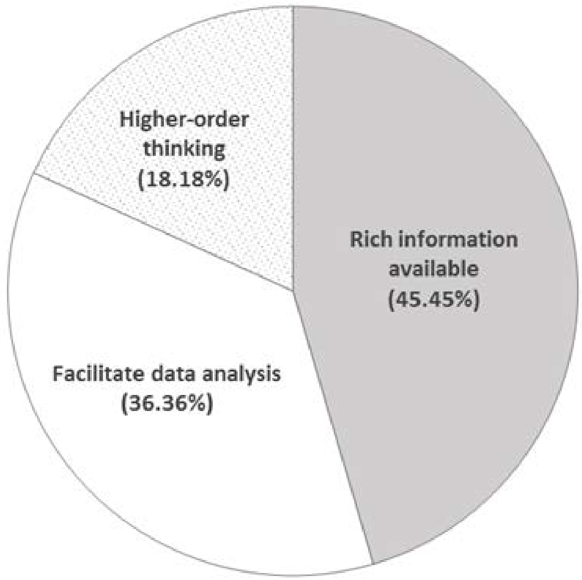

Figure 4c. *Categories of responses to "What would be benefits of using GIS in this physical geography lesson for students to achieve the learning objectives?" (*n *= 11).*

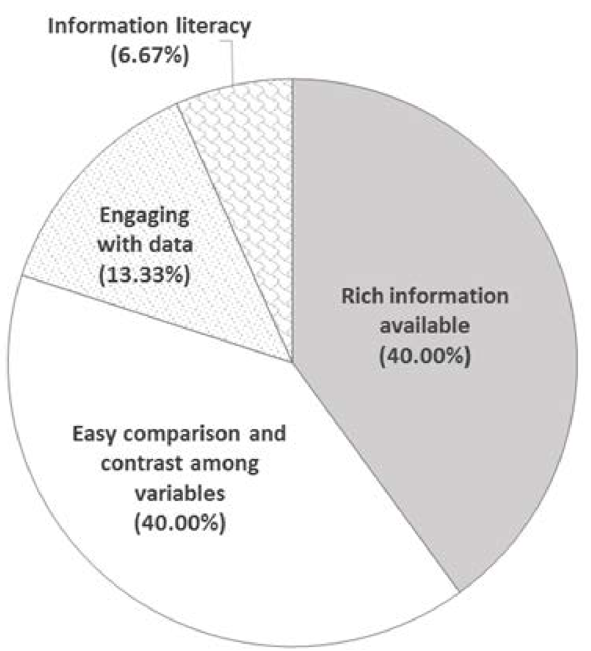

Figure 4d. *Categories of responses to "What would be benefits of using GIS in this human geography lesson for students to achieve the learning objectives?" (*n *= 15).*

Figure 4. *Participants' responses to guiding questions for reflection.*

Comments on the potential of using GIS to facilitate geographic and spatial thinking were all positive. About 28% of the comments were related to GIS as a tool to support geographic inquiry (Figure 4a). One participant said, "GIS has potential to make the process of analyzing and presenting geographic information easier, which can accelerate the geographic inquiry process." About 20% of the comments identified GIS as a powerful tool for visualization, as in the following example comment: "GIS allows students to visualize data that they otherwise may have not understood or been uninterested in had it been presented in a raw, non-visual medium."

Participant comments (15.22%) also indicated a positive attitude to GIS as it would support students' higher level thinking. According to one participant, "By introducing GIS, students will have the tools to perform these higher level thinking." Participants also recognized GIS as an effective tool for teaching and learning (10.87%). One participant said, "Students can use GIS to look at multiple ideas and sets of data through maps. This will help them understand ideas and issues quicker and more efficiently."

After a hands-on activity to learn to use basic features of AGO, such as searching for locations in a Web-mapping environment, exploring various base maps, creating map notes, and practicing map overlay and uses of simple data tables, participants were asked to write down their feeling about AGO as a tool. Overall, AGO seemed to be an eye-opening experience for most participants. One participant said,

> I thought that this activity was very enlightening. I really had no idea that this was available online for free. The amount of information that one can find on this website is amazing. The more I did the activities and tried to follow the directions, the more amazed I was that this website could do more than just show me different spots on a map just like Google maps can do.

Participant comments also indicated that the preservice teachers particularly liked AGO's base maps (21.95%), capability of adding/editing layers and map notes (21.95%), and interactive features of Web-maps, such as changing map scales (17.07%). (See Figure 4b.) Related participants' comments included the following:

- "By choosing different base maps, the user is able to see different perspectives in the area and find what they are looking for fairly easily."
- "Being able to zoom, create transparent layers, and measuring distance and area gives students all the tools they need to explore and discover."
- "I really like how you can zoom in and out of maps whereas you have access to both large and small scale maps [to do so in conventional methods]."

Several participants pointed out advantages of Web-based GIS over paper maps, for example:

> Versatility being the main pro with one website providing a multitude of maps whereas a paper map is limited to one map, two if it is printed on both sides of the paper. The ability to layer information/statistics on the virtual maps honestly makes it a tool all teachers should incorporate into their arsenal.

Despite those comments indicating positive beliefs, attitudes, and feeling of participants toward AGO as a teaching and learning tool, some statements of dissonance were also revealed. Some participants expressed specific concerns about a learning curve that their students might experience, for example, The cons would be that, at first, the students might be a little slow using it. I suggest that teachers have a prep day for the students to become familiar with the AGO website and how it operates.

No negative beliefs or dispositions were evident, though, and all participants who made remarks of concern suggested that the pros outweigh the cons. Nevertheless, the concerns identified were worth attending to in teacher preparation for using AGO.

Toward the end of the semester, participants worked on two inquiry-based lessons (one physical and the other human geography), in which they used AGO as a tool to ask geographic questions, analyze geographic information, and answer the geographic questions. Preservice teachers found it beneficial for their future students to achieve a variety of learning objectives in physical geography lessons by "[providing] student with detailed information that if it were to be given on a sheet of paper, could potentially be confusing" and visualizing information effectively and, therefore, "making it easier to analyze data than if a student were to have to rely on their mental maps" (Figures 4c and 4d). Preservice teachers envisioned that using GIS would help students "independently explore maps to examine data provided and make hypotheses that wouldn't have been as easy to do with another application" and "draw conclusions about the data." As for human geography lessons, participants expected GIS to allow students to "be able to compare and contrast multiple variables throughout the country," "illustrate the differences between densities of younger and older populations more effectively," and "better understand that data needs to be put into perspective of a whole to be able to be fully understood."

Discussion

The study findings provided answers to the two research questions presented earlier in this paper. Regarding the first question, the Web-based GIS learning experiences improved preservice teachers' dispositions regarding the use of GST for teaching and learning. Statistically significant increases in the mean scores for Items 1 and 2 on the postsurvey suggested that preservice teachers came to believe more strongly in the close relationship between GST and spatial thinking and the potential of GST in education. Participants were not confident about themselves in terms of familiarity with educational uses of GST, as indicated by the lowest mean score on the presurvey Item 3. A series of Web-based GIS experiences throughout the semester contributed to a dramatic increase in preservice teachers' self-confidence in their knowledge about the educational uses of GST, as revealed by the postsurvey result for Item 3.

Qualitative analysis shows preservice teachers can quickly recognize GST as an effective tool to facilitate geographic inquiry and higher order thinking. A simple exposure activity, such as providing relevant research articles and video clips, would be sufficient to achieve this goal. Once they saw the value of the technology for teaching and learning, initial concerns related to learning the AGO application did not prohibit them from further learning and exploration of the tool. However, the features and menus that preservice teachers were and were not able to easily navigate in AGO are noteworthy for teacher educators to help relieve the learning curve.

Participants' positive disposition toward using GST for teaching geography also appeared in their comments regarding the specific geography lesson examples. What they valued highest was that these lessons provide students with rich information and data to explore and offer opportunities to put the data in perspective and engage with them. Participants also appreciated that GST allows easy comparisons and contrasts of multiple variables over the same geographic space and facilitates processes of data analysis.

The basic premise of the second research question was that spatial thinking is inseparable from the use of GST, especially in the context of education. Findings from the study suggest that Web-based GIS activities had a positive effect on preservice teachers' dispositions toward teaching spatial thinking in their future classrooms. As shown in presurvey Item 5, most participants were not familiar with spatial thinking before the class. As the semester proceeded, their understanding of spatial thinking and how GST can support students' spatial thinking was enhanced, and participants came to believe more strongly that spatial thinking is something that should be taught in formal education.

Conclusions

Much attention has recently focused on how to enhance teacher knowledge about using GIS (e.g., Baker, 2015; Bryant & Favier, 2015; Doering, et al., 2014; MaKinster & Trautmann, 2014) but has been far less focused on how to enhance teacher dispositions toward implementing GIS into classrooms. Preservice teachers need increased awareness of and beliefs in the value of GST in education, positive dispositions toward using it in the classroom, and confidence in their own capabilities of a successful implementation of it. This kind of learning will not occur incidentally.

Given the small number of participants, the sampling of convenience, and the lack of rigorous reliability and validity testing of the instrument, this study is best considered exploratory rather than explanatory and illuminative rather than generalizable. The study of teacher dispositions for GST will benefit from research that is longitudinal with a sizable sample and refined instrumentation. Nevertheless, the findings of this study suggest that a set of simple Web-based GIS experiences aligned with geographic inquiry and spatial thinking can be effective for enhancing preservice teachers' dispositions toward using GST in their future classrooms. The findings suggest that a positive shift in preservice teachers' dispositions may be accomplished with minimal Web-based GIS experiences. These results support previous research findings that indicated that dispositions are malleable and can change within a relatively short duration (Heo, 2009; Jo, 2011). Furthermore, this study should encourage teacher educators to attend to teacher dispositions and to experiment with similar types of activities in their methods courses. A further exploration is desired. A longitudinal study with the participants would provide insights into how preservice teachers' dispositions toward teaching spatial thinking with GIS affect their classroom teaching and student learning.

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Appendix
Disposition Survey Questionnaire

Directions: Read each statement carefully and indicate your opinion based on the following scale: 1 = *strongly disagree*; 2 = *disagree*; 3 = *neutral or don't know*; 4 = *agree*; 5 = *strongly agree*						
1.	I believe that geospatial technologies, such as geographic information systems (GIS) and global positioning systems (GPS), are powerful tools for spatial thinking.	1	2	3	4	5
2.	I believe that geospatial technologies are a powerful tool for learning geography.	1	2	3	4	5
3.	I am familiar with the educational uses of geospatial technologies.	1	2	3	4	5
4.	I will demonstrate to students how geospatial technologies can be used to solve problems and make decisions.	1	2	3	4	5
5.	I know what spatial thinking is.	1	2	3	4	5
6.	I believe that spatial thinking is powerful.	1	2	3	4	5
7.	I believe that spatial thinking is integral to everyday life and the workplace.	1	2	3	4	5
8.	I believe that spatial thinking should be taught in schools.	1	2	3	4	5