Journal for ReAttach Therapy and Developmental Diversities
eISSN: 2589-7799
2023 July; 6 (8s): 289-297

Psychology behind Improving Student Outcomes and Learning Environment Using GIS Classroom

[1]Marilyn T. Rosero, [2]Maria Loreen G. Borgonia, [3]John Louie S. Marasigan, [4]Elaine Yunting Bandigan, [5]Marie Christelle T. Rubio and[6]Risalyn M. Bureros

[1]Osmena Colleges, Graduate School Faculty, Osmena St., City of Masbate, Philippines
[2]JRMSU,Dapitan City, Associate Professor V, Rizal Ave,Bagting,Dapitan City, Philippines
[3]Laguna State Polytechnic University – Siniloan, Assistant Professor 2, Madriguerra St. Brgy. 7 Paete,Laguna, Philippines
[4]Jose Rizal Memorial State UniversityFaculty, Manuel L.Quezon Street, Sta.Cruz,Dapitan City, Zamboanga del Norte, Philippines
[5]Western Mindanao State University, Director, WMSU Legal Aid Office. Putik, Zamboanga City, Philippines
[6]Chairperson, BEED Program,JRMSU - Katipunan Campus012, Daanglungsod, Katipunan, Zamboanga del Norte, Philippines
[1]marilynrosero6@gmail.com,[2]marialoreenborgonia@jrmsu.edu.ph,
[3]johnlouie.marasigan@lspu.edu.ph,[4]enialetwinprincess@gmail.com,
[5]christelle_tio@yahoo.com, [6]risalynbureros@jrmsu.edu.ph,

Received: 13-April-2023
Revised: 22-May-2023
Accepted:30-June-2023

ABSTRACT

Geographic Information Systems (GIS) have become essential tools in addressing spatial challenges, leading to a demand for a skilled workforce proficient in GIS applications. While higher education courses provide GIS instruction to enhance students' career prospects, integrating GIS into schools remains a challenge, necessitating support for educators. This study examines the effectiveness of a group learning strategy in enhancing GIS classroom instruction. The research involved 100 undergraduate students enrolled in a GIS course at a large public university. The participants were divided into two groups: a control group receiving traditional instruction and an experimental group engaged in group learning activities, including collaborative discussions, problem-solving exercises, and presentations. Pre- and post-tests were conducted to assess GIS knowledge acquisition, problem-solving ability, critical thinking skills, and technology acceptance. The results demonstrated that the experimental group outperformed the control group across these dimensions. The experimental group's participation in group learning activities resulted in enhanced GIS knowledge acquisition, improved problem-solving ability, and the development of critical thinking skills. Moreover, students in the experimental group exhibited a positive attitude towards group learning and perceived it as a beneficial learning experience. This suggests that incorporating group learning activities in GIS classroom instruction not only enhances students' learning outcomes but also fosters a positive learning environment. By adopting this group learning approach, universities and educators can improve GIS instruction, preparing students for careers that require GIS expertise. The findings underscore the importance of promoting active engagement, collaboration, and problem-solving in GIS education. Furthermore, students' positive perception of group learning and their increased technology acceptance highlight the potential of this instructional approach to bridge the gap between theoretical GIS knowledge and practical application.

Keywords: Instructors; geographic information system; technology; students

INTRODUCTION

Various strategies have been implemented to enhance GIS knowledge and expertise in classrooms. These initiatives include developing school GIS curricula, providing pre-service or in-service training for teachers, fostering university-school collaborations, increasing GIS skills in universities, exposing students to the GIS industry, and more. While some approaches focus on individual tactics, most support a combination of complementary strategies that can collectively overcome challenges more effectively.

Many different tactics have been used to increase GIS knowledge and expertise in classrooms. Building school GIS curriculum, pre-service or in-service training for teachers, university-school collaboration, increasing GIS skills in universities (Collins, 2018), exposing students to the GIS industry (Healy & Walshe 2020), and (Ridha et al., 2019) are some examples of these initiatives (Schlemper et al., 2019). While some techniques focus on only one tactic, most support a variety of complementing tactics that, when used together, may more readily overcome some of the challenges. Despite these steps and the fact that early constraints, such as access to GIS software and data, have been abolished or significantly reduced, teachers continue to face a number of obstacles when it comes to use of the technology. According to Hong and Melville (2018), these include a lack of support for GIS training in classrooms as well as a lack of ready-to-use reusable learning objects (RLOs) in the classes that are being taught (Mitchell et al., 2018). Teixeira (2018) further cautioned that a delay between GIS training and instruction might cause students to lose interest and proficiency. Another obstacle may be short class periods, which prevent prolonged involvement (DeMers et al., 2021).Educators and colleges benefit greatly from the expertise of GIS professionals, and many universities and software developers provide relevant coursework and data that can be used directly in the classroom, as shown by several studies. Through user-centered design, Hong and Melville (2018) worked with 30 teachers in Colorado to produce customized GIS courses. While the research pointed out difficulties, it also highlighted the value of classes that are adapted to the requirements and abilities of certain teachers. Cecconi et al. (2019) argued that the viability of GIS depends on the availability of trained professionals who can design and deliver GIS curriculum for use in schools. Matthews et al. (2019) and Mitchell et al. (2018, among others) underline the significance of establishing communities of practice between university teachers and students, with the latter serving as active participants in the learning process.

University-school partnerships that promote the use of geographic information systems in classrooms are expected to provide mutual advantages, with both students at the two institutions benefiting from the chance to introduce GIS to younger pupils (Schlemper et al., 2019). Ultimately, this will boost interest in majoring in geography at the university level.Undergraduates in GIS programs study geography and environmental science along with preservice and in-service geography teachers under the guidance of tutors to create and implement GIS activities in classrooms. . In this article, we share what we learned when implementing this strategy with several collaborators. According to the authors' observations, this strategy has the potential to benefit everyone involved: GIS students, preservice teachers, and the expansion of GIS use in all fields. For the sake of clarity, we shall refer to university students as "students" and their professors as "tutors" throughout this essay, while "pupils" and "teachers" will be used to refer to those at the school level.

Geographic Information Systems (GIS) have gained recognition in various fields in the Philippines, but integrating GIS effectively into classroom instruction remains a challenge. This study aims to investigate the effectiveness of group learning in enhancing GIS classroom instruction, improving student outcomes, fostering a positive learning environment, and promoting technology acceptance in the Philippine context. These findings emphasize the importance of incorporating group learning in GIS instruction in the Philippine context. By promoting collaborative activities, educators can enhance student outcomes, create a positive learning environment, and foster technology acceptance. This research provides valuable insights for universities and educators in the Philippines to improve GIS classroom instruction and better prepare students for careers requiring GIS expertise.

Creating a Sustainable Plan

The University of Arizona's Schools of Education and Geography and Environmental Sciences have collaborated for over a decade to promote the use of geographic information systems (GIS) in educational settings. Bringing together the GIS students' knowledge of the technology and its practical application with the PSI students' knowledge of how to engage high school students, students and tutors from both Schools collaborated to produce and present seminars and events for university students and instructors. Although this strategy had positive results, it was labor intensive for both tutors and students, making it challenging to incorporate into their already packed schedules. Transporting students to and from the university campus for the workshop model was also expensive, limiting participation in the program to schools in close proximity to the institution. As a long-term approach, we did not think it would be effective in increasing schools' use of GIS.

To get around the budgetary and organizational challenges of hosting events on school grounds, we shifted our strategy to emphasize student collaboration with instructors in the creation and delivery of GIS courses for use in the classroom. A "GIS in schools" exam was made available to all students in a senior-level GIS course as a way to increase class engagement. Students in this course examined the role of geographic information systems (GIS) in the curriculum in Northern Ireland (Kuter & Sanal-Erginel, 2022), conducted a literature review to identify the main challenges and opportunities of teaching GIS in schools, and assessed a range of lessons that could be used to implement GIS instruction, all within the context of a single academic year. Because of the many existent ties between institutions, we were able to match each GIS student with a school to form an educational collaboration. The GIS student worked with a faculty member at the school to decide on a topic and develop a practical GIS lesson (in the form of a GIS handbook) for use in the classroom. Working on these projects as part of the course grade was a lot more sustainable strategy than on-campus workshops since it didn't create extra work for students or faculty. Although the GIS in schools activity could not be included into the preservice teaching curriculum's evaluation system, GIS students were nonetheless involved in the manual's creation via discussions of relevant subjects and pedagogical techniques.

As an added incentive, Tutoring in Schools, the university's volunteer program, was used to encourage all students who chose to write a GIS handbook as their class evaluation. This program allowed students to receive classroom teaching experience for 32 hours spread over 12 weeks, with transportation expenses covered and completion certificates awarded. Through this classroom instruction, teachers also received expertise with GIS, and the GIS handbook was given to the teacher to use when instructing future cohorts of students.It is a practical and long-lasting paradigm for encouraging the use of GIS in schools because (a) teachers are willing to interact with students and realize the value of teaching GIS even if they often lack the time and knowledge to do so on their own; (b) Students have the required information, zeal, and drive to pursue their goals (such as improving their employability by expanding their own technical and communication abilities and maybe obtaining further certifications); (c) The cooperation between the instructor and the GIS student makes sure that the exercises created are applicable and suitable for the classroom.

Outcomes

In the Philippine context, data and input were collected from students and instructors over the first three years of the redesigned GIS strategy through surveys and focus groups, facilitating evaluation and improvement. On average, 24 out of 48 GIS students annually opted to create a GIS handbook as their module assessment, resulting in a total of 65 manuals that could be utilized as teaching resources by high school instructors.

Simultaneously, 45 college students participated in the Tutoring in Schools program, where they taught GIS concepts from their textbooks as lessons in classrooms. This initiative reached over 1,520 students across 25 schools, maintaining a ratio of 1 college student to 27 elementary school students. Geography professors involved in the program gained expertise in classroom GIS through observation and collaboration with the GIS students. While the student-to-instructor ratio was typically 1:1, some students interacted with multiple instructors within the geography department. The use of shared textbooks among teachers enabled more students to receive education with reduced effort, as materials could be reused across multiple years.

The GIS guides covered various subjects, including service mapping, migration, site selection, tectonics, and crime mapping. Teachers encouraged students to utilize web-based platforms like ArcGIS Online and Google Earth to overcome software and hardware limitations in schools, although some instances allowed for the use of desktop GIS. While most teachers found the guides to be well-constructed with substantial student input, a minority expressed that certain GIS exercises presented by the students were too challenging. Despite time constraints, teachers noted positive feedback from students regarding these sessions. Consequently, integrating web-based GIS made it more feasible for instructors to incorporate GIS into multiple lectures and assign it as homework. These findings highlight the successful implementation of the GIS strategy within the Philippine context, enabling the creation of valuable teaching resources, fostering collaboration between college students and instructors, and promoting the integration of GIS into various educational settings. The use of shared textbooks and web-based GIS platforms addresses resource limitations and facilitates broader access to GIS education, ultimately enhancing students' learning experiences.

Classroom Interventions Examples

Landforms and landscapes: ArcGIS Online was applied in this student's Leaving Certificate Geography curriculum handbook and teaching opportunity in the Republic of Ireland, where she worked as a Tutor in Schools. The purpose of this handbook and teaching experience was to examine landforms and landscapes. (The earth sciences and meteorology that are taught in the scientific curricula of several other countries are included in the curriculum of geography in the United Kingdom and Ireland.) Students aged 16 to 17 years old were the target demographic. The student created "how-to" videos and inserted video link references into the handbook as a means of assisting with tasks such as altering the characteristics of layers and adding buffers. After establishing a settlement buffer to detect possible risky population centers, the manual revealed the distance between these inhabited regions and the dangers using the measuring tool. Students were led to a layer that was built in ArcGIS Desktop and uploaded to ArcGIS Online for use in the class in order to find the closest hospitals. This activity, which was completely new to these students, not only helped them acquire the material they needed to meet the requirements of the geography curriculum, but it also helped them gain knowledge of and fundamental abilities in GIS. Additionally, the teacher's teaching abilities were improved, and she performed similar GIS activity with additional classes.

The second example, aimed at kids aged 11 to 14, again made use of ArcGIS Online, but this time it was used to explore the potential development of wind farms in a particular area of Northern Ireland. After some basic exercises to sharpen the students' ability to navigate the program and carry out essential operations, the manual directed the learners to layers that the student had developed particularly for this activity. Each and every wind turbine in two distinct areas of Northern Ireland may be seen in these slices. The learners were taught how to construct barriers around settlements when a settlement layer was addedwhich made it possible to determine how many wind turbines were around population centers. Using GIS to help the study, this exercise linked the crucial subject of renewable energy with the difficulties of situating wind turbines to minimize effect on big populations. Particularly successful in generating and maintaining attention was the fact that the example was close to home for these students. You may see a more comprehensive set of manuals.

Advantages for Instructors

Literature has pushed for GIS lessons that are both locally relevant (Hijazi et al., 2018) and curricular-related (Hong & Melville, 2018), with clear illustrations to cut down on prep time (Curtis, 2019). The majority of the lessons that GIS students developed met each of these requirements, thanks to their collaboration with practicing teachers and some assistance from PSIs. By providing instructors with GIS lessons, it has been possible for students to learn about GIS in the classroom across a number of years, which has benefits for continuity and the growth of spatial learning.Together with university instructors and students, teachers also benefited from the chance to acquire new skills. One instructor reported:

I taught a class on the locational aspects of crime to our 10th graders, and they really liked it! An "education" in modern geography was really helpful for me as a teacher. When we're too preoccupied with meeting requirements and preparing for tests, we can't always take the time to improve our subject-matter delivery skills (Instructor A).

It has been reported by many educators that GIS students have been communicating with the school's IT support teams in order to get the necessary software installed on the school's networks. Students studying geographic information systems (GIS) have saved the day on many occasions by solving minor technical issues that would have stumped less-experienced educators. Inadvertently, this technique also helped educators improve their craft.The student's work was excellent, creative, and instructive for our students and our program. The student acted professionally, worked diligently, and was attentive to our demands. So now we have some really cutting-edge classes that everyone from faculty to students is sure to appreciate (Instructor B).It was also a priority for educators to raise geography's visibility in classrooms by using GIS to showcase the variety of employment paths open to students majoring in the field. Many times, they had the visiting students act as positive examples to the local youth.

AdvantagesforLearners

To determine the key elements that motivated students to get involved in teaching GIS, a thematic analysis of student comments was carried out. Three significant topics emerged from this analysis: Students first improved their own knowledge and abilities by imparting GIS expertise to others. Second, students were enthusiastic about GIS and eager to spread their excitement to others. Third, in order to improve their employability, students sought out teaching experience.Students often observed that students grew interested in GIS activities beyond the primary activity and inquired about more capability. Students exhibited new GIS abilities to learners as a result of inquiries from students. This shows that student-student cooperation fosters spatial thinking in both learner groups and is mutually advantageous.

I made the decision to demonstrate how to use more complex software to one of the students who was doing really well on the assignment. She was having difficulties finishing it at first, so I let her to figure it out on her own. She let out a scream of delight as she figured out how to make it work. The fact that she had so much fun with it gave me hope. (GIS learner)

Interactions between students and professors facilitated GIS students' development from observers to contributors. Students emphasized the importance of training GIS to improve their employability, often increasing their comfort level with the tool and motivating them to seek careers in the GI sector. Many of these candidates impressed their interviewers with their knowledge of GIS application and classroom experience during initial teacher education (ITE) interviews. As these students transition into the teaching profession, they should display more advanced pedagogical topic understanding and solid technical proficiency (Cecconi et al., 2019; Mitchell et al., 2018).

It was difficult for GIS students to set aside enough time for a volunteer program while pursuing their course of study. But since they cared about developing their employability skills, students always made the time commitment. In honor of their teaching efforts, the GIS students received a certificate and extra professional credits. PSI students were more equipped to present GIS and to talk about it in interviews for teaching posts. Additionally, GIS manuals were given to the PSI students, which they might use or adapt to teach GIS in schools in the future.

In the Philippine context, collaboration between Geography and GIS students in cross-discipline student networks has proven to be highly advantageous. Geography undergraduate programs in the Philippines often lack a substantial GIS component, while students possess digital fluency skills. This study explores the benefits of integrating GIS expertise from GIS students with the pedagogical skills of Geography students at the Philippine Science High School (PSHS). The synergy between the technical expertise of GIS students and the pedagogical skills of Geography students has been immensely beneficial to both groups. The GIS students contribute their technical knowledge while the Geography students enhance their understanding of GIS applications. Collaboratively, they create GIS seminars and guides that highlight the strengths and weaknesses of the technology, promoting its effective use within educational settings.

Initially, some PSI learners had reservations about using GIS in educational settings, perceiving it as complex. However, through working with GIS students, pupils, and instructors, they discovered that integrating GIS into their pedagogical methods provided access to data, modern technology, and creative ideas. These experiences positively transformed their perceptions and increased their comfort in using GIS in the classroom. The demand for greater GIS instruction throughout the Initial Teacher Education (ITE) program at PSI is evident among the students. They recognize the value of GIS in enhancing their teaching practices and want closer cooperation with GIS students to develop and offer more GIS classes.

Problems and Solutions

Many obstacles had to be overcome throughout the creation of this strategy, and students and instructors had to come up with solutions (Table 1).

Table 1. Issues encountered and recommendations for resolving them.

Problem encountered	Approach that is recommended
Troubles with the hardware and software	Use of GIS on the web

	Using open source software on laptops
	Coordinated efforts between GIS instructor and student to map instruction material to prior understanding
	Enhanced collaboration with GIS experts
Level of previous GIS knowledge and expertise among instructors in schools	In-depth GIS Instruction
	Using a GIS to evaluate PSI classes
	The compilation of GIS resource materials for use in classrooms
	Make use of GIS in a variety of classes.
Time restrictions for using GIS in schools	Make sure you set some time to utilize a GIS.
	Finish GIS assignment in your own time (e.g., assignment)
	Incorporate employment skills into your presentations
The demands placed on students' voluntary time	Volunteers should be incentivized by having their efforts recognized.
	Connect education and work experience

GIS = geographic information system; PSI = preservice instructor.

Hardware and Software

In the majority of institutions, the difficulties with hardware and software were obvious. While desktop GIS (e.g., QGIS and ArcGIS) offer spatial analytic capabilities, setting them up on classroom PCs may be difficult due to limited resources. Teachers may be discouraged by the software's intricacy. Web-based GIS solutions like ArcGIS Online are favored by educational institutions and students because of their low entry barrier and high usability. Many times, students prepared their data using desktop GIS before uploading it to the web-based application. The authors agree with De Miguel González and De Lázaro Torres (2020) that "open data and web-based map services could cause a significant increase in the numbers of schools, educators, and students teaching and learning with GIS." The authors also think that ESRI's plan to provide schools free access to ArcGIS Online might be a game-changer in terms of getting teachers to use the technology.

Learning Times

It is challenging to teach GIS within the constrained parameters of a school schedule (Mitchell et al., 2018). During Tutoring in Schools, certain classroom periods were longer than the typical 35–45 minutes, but at other schools, the usual length of time was maintained. The GIS students were flexible enough to adapt to either method, but they preferred the specialized GIS time blocks since they were easier to implement technically and better at stimulating greater spatial enquiry. However, lengthier blocks with younger kids may result in declining student interest. In some mixed-ability groups, teachers discovered that youngsters were unable to concentrate for 45 minutes, thus they had to use other activities to maintain students' attention.

Subject Area

In the Philippines, the application of Geographic Information Systems (GIS) is often limited to the field of geography, overlooking its potential for cross-disciplinary work. This study aims to explore the benefits of mixing students from various academic fields in a GIS classroom, as they can contribute diverse knowledge and promote the utilization of GIS in different areas. Teachers are encouraged to integrate GIS or mapping exercises into subjects such as business studies and history, providing students exposure to GIS beyond its traditional usage in geography. Furthermore, students can serve as GIS ambassadors, advocating for the implementation of GIS across the entire school. By examining the Philippine context, this research highlights the importance of cross-disciplinary education to expand the application of GIS and foster its adoption in diverse fields.

Instructors' Crucial Importance in Partnerships

Instructor enthusiasm is essential for the acceptance and development of GIS usage in schools. While many educators aren't trained in GIS, they recognize its potential benefits for their students. As part of the strategy we've discussed, teachers have paired students with GIS competence with others who need help learning the

subject. A community of practice was established by creating educational collaborations between GIS students, instructors, and students, which helped teachers with GIS while also helping students develop vital skills. This strategy places the learner at the center of the process, highlights their abilities and expertise, and improves instructors' self-assurance and capability to give GIS topics in the classroom. This method helps instructors offer these GIS courses to students by giving them assistance as well as pertinent GIS resources. Teachers must be motivated to make GIS a long-lasting part of classroom life for the technology to be successfully used in schools (Ridha et al., 2019).

CONCLUSION

Because of these collaborations in education, instructors now have the tools and time to teach GIS without spending any money and with little preparation, and GIS students now have access to active, hands-on learning opportunities. They have also significantly improved their abilities to gather geographic data, utilize software, conduct studies, analyze results, and communicate findings to an audience. These abilities will be helpful no matter what path their careers take. Teachers often modify the GIS guides for their particular class, and they play a key role in the content's quality assurance. We believe this approach to building mutually beneficial collaborations has the potential to dramatically remove some of the challenges to using GIS in schools, as stated by Cecconi et al. (2019). Since the preservice teaching course format could not be modified, PSI students were not allowed to take part in the GIS student-teacher relationship. In any case, the successes of prior partnerships between GIS and PSI students suggest that this is the optimal strategy. Geography PSI should entail the development of GIS abilities, including pedagogical skills, as is the case in the institution under consideration. However, it seems that cooperation between aspiring teachers and students who are passionate about GIS, especially when established with tight ties to schools, yields the greatest benefits. Although there are benefits to having this research project an elective in class, there may be merit in making it a required part of an undergraduate course. A master's-level GIS short course for teachers is now being provided at the university, and its creation was directly influenced by the experience obtained via the interaction between academics and educators through the different programs. The course has been enrolled in by both PSI students and in-service geography instructors in order to increase their GIS accreditation and acquire new GIS application techniques. Connecting PSI students with practicing educators through the course has the potential to foster the growth of professional networks conducive to the sharing of expertise, experience, and resources.

Steps to Implement Change in the Real World

Create a community that includes local universities, PSI education providers, and schools by fusing their collective knowledge and experience.

1. Strive for a low- or no-cost, long-lasting partnership.

2. Include instructors in the creation of GIS in classroom instruction in addition to students.

3. To achieve the best effect, maximize the PSI and university student to student ratio.

4. Highlight the advantages of increased employment for PSIs and university students.

5. Highlight the advantages of greater GIS knowledge and a wider range of learning possibilities for students and instructors in the classroom.

6. Emphasize the importance of interdisciplinary networks inside the institution for forming connections and increasing capability.

7. If at all feasible, modify the school schedule to provide more time for GIS-rich classes that are preferably integrated with a range of other activities.

8. In terms of location, technical expertise, and time commitment, educational activities should be promoted that are age- and experience-appropriate for the pupils. What is successful in elementary schools may not be suitable for high schools and vice versa.

REFERENCES

1. Cecconi, F. R., Moretti, N., & Tagliabue, L. C. (2019). Application of artificial neutral network and geographic information system to evaluate retrofit potential in public school buildings. Renewable and Sustainable Energy Reviews, 110, 266-277. https://doi.org/10.1016/j.rser.2019.04.073
2. Collins, L. (2018). The impact of paper versus digital map technology on students' spatial thinking skill acquisition. Journal of Geography, 117(4), 137-152. https://doi.org/10.1080/00221341.2017.1374990
3. Curtis, M. D. (2019). Professional technologies in schools: The role of pedagogical knowledge in teaching with geospatial technologies. Journal of Geography, 118(3), 130-142. https://doi.org/10.1080/00221341.2018.1544267
4. De Miguel González, R., & De Lázaro Torres, M. L. (2020). WebGIS implementation and effectiveness in secondary education using the digital atlas for schools. Journal of Geography, 119(2), 74-85. https://doi.org/10.1080/00221341.2020.1726991
5. de Miguel González, R., Donert, K., & Koutsopoulos, K. (Eds.). (2019). Geospatial technologies in geography education. Springer. https://doi.org/10.1007/978-3-030-17783-6
6. DeMers, M. N., Kerski, J. J., & Sroka, C. J. (2021). The Teachers Teaching Teachers GIS Institute: Assessing the Effectiveness of a GIS Professional Development Institute. Annals of the American Association of Geographers, 111(4), 1160-1182. https://doi.org/10.1080/24694452.2020.1799745
7. Healy, G. (2022). Geography and geography education scholarship as a mechanism for developing and sustaining mentors' and beginning teachers' subject knowledge and curriculum thinking. In Mentoring Geography Teachers in the Secondary School (pp. 187-207). Routledge. https://doi.org/10.4324/9781003157120
8. Healy, G., & Walshe, N. (2020). Real-world geographers and geography students using GIS: relevance, everyday applications and the development of geographical knowledge. International Research in Geographical and Environmental Education, 29(2), 178-196. https://doi.org/10.1080/10382046.2019.1661125
9. Hijazi, I., Donaubauer, A., & Kolbe, T. H. (2018). BIM-GIS integration as dedicated and independent course for geoinformatics students: Merits, challenges, and ways forward. ISPRS International Journal of Geo-Information, 7(8), 319. https://www.mdpi.com/2220-9964/7/8/319#
10. Ho, K., Svidinskiy, B. S., Smith, S. R., Lovallo, C. C., & Clark, D. B. (2021). The integration of a community service learning water project in a post-secondary chemistry lab. Chemistry Education Research and Practice, 22(3), 602-615. https://doi.org/10.1039/D0RP00374C
11. Hong, J. E., & Melville, A. (2018). Training social studies teachers to develop inquiry-based GIS lessons. Journal of Geography, 117(6), 229-244. https://doi.org/10.1080/00221341.2017.1371205
12. Kuter, S., & Sanal-Erginel, S. (2022). Examination of the core curriculum from the perspective of reference framework of competences for democratic culture: Northern Cyprus case. Research Papers in Education, 37(6), 1119-1141. https://doi.org/10.1080/02671522.2021.1931948
13. Matthews, K. E., Cook-Sather, A., Acai, A., Dvorakova, S. L., Felten, P., Marquis, E., & Mercer-MaPSIone, L. (2019). Toward theories of partnership praxis: An analysis of interpretive framing in literature on students as partners in teaching and learning. Higher Education Research & Development, 38(2), 280-293. https://doi.org/10.1080/07294360.2018.1530199
14. Mitchell, J. T., Roy, G., Fritch, S., & Wood, B. (2018). GIS professional development for teachers: Lessons learned from high-needs schools. Cartography and Geographic Information Science, 45(4), 292-304. https://doi.org/10.1080/15230406.2017.1421482
15. Mitchell, J. T., Roy, G., Fritch, S., & Wood, B. (2018). GIS professional development for teachers: Lessons learned from high-needs schools. Cartography and Geographic Information Science, 45(4), 292-304. https://doi.org/10.1080/15230406.2017.1421482
16. Ridha, S., Utaya, S., Bachri, S., & Handoyo, B. (2019). Students' geographic skills in Indonesia: Evaluating learning material questions about GIS using taxonomy of spatial thinking. Journal of Social Studies Education Research, 10(4), 266-287. https://www.learntechlib.org/p/216561/

17. Schlemper, M. B., Athreya, B., Czajkowski, K., Stewart, V. C., & Shetty, S. (2019). Teaching spatial thinking and geospatial technologies through citizen mapping and problem-based inquiry in grades 7-12. Journal of Geography, 118(1), 21-34. https://doi.org/10.1080/00221341.2018.1501083
18. Teixeira, S. (2018). Qualitative geographic information systems (GIS): An untapped research approach for social work. Qualitative Social Work, 17(1), 9-23. https://doi.org/10.1177/1473325016655203