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Using Problem-Based Learning and Gamification as a Catalyst for Student Engagement in Data-Driven Engineering Education: A Report

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Abstract: This report explores the integration of problem-based learning, gamification, and data-driven approaches in engineering education. With a focus on the course "GeoGovernment 1", this framework aimed to engage students actively and foster self-directed learning. By tackling real-world issues like automated teller machine (ATM) burglaries in Rhineland-Palatinate (Germany), students gained experience in data analyses and geoinformatics technology. This approach not only motivated students but also enhanced their prospects in science, technology, engineering, and mathematics (STEM) fields, equipping them with skills necessary for their future careers. The course structure emphasized student-centered learning, with educators playing facilitative roles to provide guidance. In summary, the combination of problem-based learning, gamification, and data-driven approaches offers a promising solution to address the challenges faced by STEM education, providing an engaging and effective learning experience for students, and ultimately preparing them for the demands of the ever-evolving professional landscape.

Keywords: engineering education; problem-based learning; gamification; STEM education; data-driven education

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1. Introduction

Engineering education, as a part of science, technology, engineering, and mathematics (STEM) education, plays a key role in shaping the future of our society, especially regarding the link between science and technology on one hand and sustainable economic growth on the other [1]. The emergence of new technologies and the rapidly evolving and ever-changing professional demands put the educational system under a state of continuous challenge. Thus, educational institutions must adopt effective pedagogical approaches that empower students with the skills and expertise necessary to be successful in real-world engineering challenges (e.g., in their future jobs).

In recent years, integrating data-driven approaches, gamification, and problem-based learning gained substantial attention as promising strategies to enhance engineering students' engagement, motivation, and knowledge acquisition [2–4]. Gamification is defined as the application of game elements and mechanics outside their primary context [5] and has shown enormous potential in transforming traditional educational approaches. Leveraging game-design principles such as challenges, rewards, competition, and gamified learning experiences can captivate the students' attention, motivate them, and promote active participation in the learning process [6]. The elements of feedback, progress tracking, and an ever-present sense of achievement present in gamified environments contribute towards immersive and enjoyable educational experiences [7].

Problem-based learning offers an educational framework that enables students to apply theoretical knowledge to real-world problem-solving scenarios. By offering the students the opportunity to engage themselves in authentic projects, they gain hands-on experience, develop critical thinking skills, and cultivate a deep understanding of the implications of their academic studies [8]. Furthermore, the framework encourages collaborations, promotes interdisciplinary thinking, and fosters the integration of multiple skills that are very relevant in the STEM field, including communication, teamwork, and creativity [9].

Data-driven approaches also emerged as a powerful tool in engineering education, leveraging the vast amounts of data available from various sources. This type of approach allows for personalized learning experiences, fostering individual growth and addressing the diverse needs of engineering students.

In this report, we aim to explore (a) a framework that combines elements of (1) problem-based, (2) gamified, and (3) data-driven approaches in one course, and (b) the synergistic effects that result from this. By examining already existing studies and drawing upon our own experiences, we will investigate how the approach combination contributes to student engagement and self-directed learning. To accomplish this, we planned and implemented a new pedagogical concept in the Geoinformatics Master's degree program as part of the "GeoGovernment 1" course, which combines elements of all three previously mentioned approaches in a real-life, highly relevant topic. We seek to provide educators and curriculum designers with insights and recommendations for incorporating gamification, problem-based learning strategies, and data-driven approaches in engineering education.

1.1. GeoGovernment

Developments in the digital workflows of administrative processes (eGovernment)—such as online services and portals, data integration and interoperability, open data, and transparency—are increasingly challenging and influencing administrations and administrative action. Influenced by the rapid changes in IT, national and international administrations face various challenges that, for example, arise from the open data trend, whilst it has great potential, especially in the field of open government data, for the development of public policies, democratic dialogue, entrepreneurship, etc.

However, even if numerous benefits emerge from the opening up of government data to citizens and companies (transparency, the reliability of administration, the promotion of public participation, and finally, the revitalization of the economy), we must also be aware of the major limitations arising from the usage of large open databases. Just publishing raw data does not mean that they are ready to be used—there is a skillset needed to download, clean, order, analyze, and interpret open data in the context of geo-government. Kassen [10] states that reusing and processing open data require skilled enthusiasts and tech-savvy citizens who contribute their time, knowledge, and expertise to the creation or co-creation of products and policies based on open data.

To address this, the Carl Zeiss Foundation endowed a professorship in "GeoGovernment" at the Mainz University of Applied Sciences for five years—the first of its kind in Germany. As part of the endowed professorship, new skills and expertise are to specifically developed in the area of eGovernment, geoinformatics, and geodesy. For context, handling open source and open data to visualize information of police press releases would fall within the scope of the GeoGovernment. The professorship occupies a place in the Bachelor's and Master's degree programs in geoinformatics and surveying. These degree programs give the students the possibility of putting their study profiles together according to their wishes—either focusing on surveying or deepening their knowledge on geoinformatics. In both cases, the disciplines can be defined as science and engineering subjects and as part of STEM higher education. STEM education is essential for societal growth due to the critical role of science and technology in economic sustainability [11]. It solves complex social problems by integrating scientific, technological, engineering, and mathematical knowledge. By enabling students to address real-world challenges, STEM education has the goal of preparing a scientific labor force to contribute to society [1]. The necessity to educate a workforce is extremely high, and the gap between supply and demand is growing: the U.S. Bureau of Labor Statistics projects a 10.8% growth between the years 2021 and 2031. This doubles the number of non-STEM occupations. STEM jobs also pay substantially more: with a median annual wage of USD 95,420, it is more than double the no-STEM counterpart (USD 40,120) [12].

In theoretical terms, the prospect of a comparatively high income and the near-guaranteed possibility of easily finding employment would encourage students to apply to universities that offer a STEM-related subject. Unfortunately, this is not the case. The number of students who enroll in such degree programs is steadily declining. For example, in 2021, around 307,000 students chose a STEM major as their desired topic in the first semester, which is a 6.5% drop compared to the previous year [13]. This can be explained by the demographic changes and the drop in enrollment numbers of international students because of the COVID-19 pandemic. These negative demographic trends are only projected to end when the 2011 cohort enrolls in universities, so the problem is not a short-term one [13]. The student retention rates do not look promising either. The majority of students who enroll in STEM-related majors do not graduate with a STEM degree [14]. In Germany, about 49% of students who start a degree in the field either drop out or change to another subject [13]. In a three-year study based in seven different universities in the United States, Seymour et al. [15] reported that about 40% of those who enroll in engineering degrees change to non-science or non-technical majors, 50% drop out of physical and biological sciences, and 60% drop out of mathematics programs.

A big factor contributing to low retention rates in STEM is poor teaching—Seymour et al. [15] argue that it is the third highest reason for leaving science. More than 90% of students who leave STEM-related studies are concerned about the quality of teaching, especially the lack of interaction, preparation, and organization. Overall, they are criticizing a lack of encouragement of discussions and the sense of discovering things together [15]. Watkins et al. [16] propose that offering students the opportunities to actively think, respond, and interact in classrooms may have an impact on the students' decisions regarding whether they should stay in STEM disciplines or not. In addition, Daempfle [17] provided evidence that teacher interaction and interactive teaching in the classroom have an effect on retention, although the extent of the effect varies in relation to gender and student background.

To tackle these problems, we researched actual pedagogical approaches and looked toward frameworks that actively engage students in learning. The most promising approaches implemented in modern education that we could identify were problem-based learning (PBL) and gamification.

1.2. Gamification in Engineering Education

Gamification, in a broader sense than just education, is most commonly defined as the application of game design elements and game principles in non-game contexts [5]. Such elements include, for example, earning points, overcoming a challenge or receiving prizes for completing tasks, following a narrative, having player control, receiving immediate feedback on certain actions, having the opportunity for collaborative problem-solving, etc. [18]. In an educational environment, it allows the educator to challenge students in a fun and engaging way by creating real-life scenarios that can ultimately help students in their future professional lives by building critical thinking and social skills as well as professional expertise [19,20]. Combining education and gaming elements can motivate students to engage more actively in their learning, and give teachers better tools to guide and reward students [21].

STEM education, as described, is pretty demanding on students, but it has a huge beneficial effect: it offers students a familiar, playful environment in which they can thrive. Playing games and therefore using game elements and game mechanics is a "language" that students can speak, it is inherent to them, and it is used as a mechanism to develop their autonomy, competence, and relatedness [18]. Additionally, the JIM-Studie 2022 [22] shows that 94% of 12–19-year-olds play videogames: 76% play daily or several times a week, 10% once per week or every 14 days, 8% once a month or less often, and 6% never. Subsequently, it is a logical conclusion to provide students with a familiar environment that they have grown up in and most of them still engage in on a daily basis when they need to learn complex theoretical concepts and their practical implications.

From the standpoint of effectiveness, gamification strategies are highly relevant and effective [19]. Empirical evidence suggests that gamification not only motivates students to conceive the information that the educator conveys theoretically, but also helps them to understand how to manipulate and leverage the acquired information in a real-life, practical manner [19,23].

Learning GeoGovernment is a complex field that combines programming, engineering, and data science. As such, we wanted to ease the workload and stress of students by offering them a familiar but highly effective environment for learning in by implementing gamification in our curriculum. One challenge we anticipated was that the balance between playing and learning would be hard to uphold, so we decided to implement a novel approach and combine gamified teaching and learning with another similar, but didactically more structured framework: problem-based learning.

1.3. Problem-Based Learning

To move forward, we need to differentiate between problem-based and project-based learning. Project-based learning is a systemic teaching method and overall approach to the design of learning environments that emphasizes learning through projects [24]. In this method, students look at real-life problems in their natural setting from an interdisciplinary standpoint and develop products in the classroom as solutions to these problems [25]. Students gain a more in-depth comprehension when they can build their understanding by working with and using ideas [26]. Moving the focus from a passive intake of information (i.e., frontal teaching) towards a more engaging, real-life explorational skill development helps the student by already contextualizing theoretical concepts in a professional environment.

Problem-based learning, on the other hand, is a teaching strategy where the teaching approach is changed in favor of the student by setting the focus on the development of problem-solving, creativity, and critical thinking skills. Tan [27] defines it as a "progressive active learning and learner-centered approach where unstructured problems are used as the starting point and anchor for the learning process".

While similar, these are two different approaches—problem-based learning is driven by the problem and focuses on research and inquiry, while project-based learning is driven by the product and the process of production. Noordin [28] assert that PBL is a subset of project-based learning and as such, implementing project-based learning also implements PBL. A further distinction is made in their article (see Table 9, Page 3).

Learning environments that are project-based show some common features [26,29]:

(1) They start with a driving question. These are ill-structured problems that are presented as unresolved so that the students can generate a plethora of causes, but also a plethora of solutions for those problems [30,31].
(2) Students explore the question by participating in situated inquiry—processes of problem-solving that are similar or identical to those of experts in the discipline. Authenticity is the key factor when selecting a problem. Authenticity is embodied by the alignment to the professional or real-world practice [30,31].
(3) Students, teachers, and community members engage in collaborative activities to find solutions to the question—similar to team activities in a professional environment. The problems are generally cross-disciplinary, and students need to investigate multiple subjects to be able to come up with workable solutions [30,32]. The educator acts as a facilitator or tutor in the learning process and initially prompts students with meta-cognitive questions, then gradually decreases this guidance [30,31].
(4) While engaging in the inquiry process, students are equipped with technologies to help them participate in activities that are normally beyond their ability.

(5) Students create a set of tangible products as answers to the driving questions. These are shared artifacts, publicly accessible external representations of the class's learning.

While problem-based learning is not the only method of approaching ill-structured and complex problems while teaching, there is empirical evidence that it is more effective in comparison to conventional classroom teaching when it comes to long-term retention, skill development, and the satisfaction of students and teachers [33]. Galand et al. [34] showed that, when applied to an engineering curriculum, students who enrolled in a program with a PBL curriculum outperformed those from the conventional one, especially in the application of knowledge.

For our approach, we decided to focus on PBL, as handling an ill-constructed problem and driving question was the main goal of the course, but we still borrowed some methods of project-based learning, especially in designing the learning environment.

2. Materials and Methods

We implemented the proposed approach in the 2022/2023 winter semester in the "GeoGovernment 1" course as part of the Geoinformatics and Surveying Master's degree program. The course focuses on getting students in a position to grasp the concepts of GeoGoverment and the underlying processes. To do this, they need to be data literate within the context of geo-spatial data (i.e., the ability to read, write, and communicate data in context, including an understanding of data sources and constructs, analytical methods, and techniques applied, and the ability to describe the use case, application, and resulting value [35]). Furthermore, they need to be put in a position to conduct GIS analysis on their own—create, manage, transform, and visualize all types of (spatial) data [36].

To satisfy the requirements of authenticity, collaboration, and the public displaying of the student's work, we cooperated with the state criminal police agency of Rhineland Palatinate (Landeskriminalamt Rheinland-Pfalz), whose representatives acted as mentors for the students. Nine students enrolled in the course. At the start of the term, they had to choose between two groups: they could either be "cops" or "robbers". Based on their decision, they had to approach the project goal from two different perspectives. Both groups had 14 weeks to work on their solutions, which were presented in the last lecture of the semester. The problem to be solved is based on a contemporary example. In recent years, there has been an observable increase in automated teller machine (ATM) blasting in Germany, which not only causes financial damage, but it also poses a significant threat to public safety. The outstanding question was how to integrate this topic in the professional framework of an engineering degree.

Crime mapping is an analytic approach that combines geoinformatics methods and crime data. Geographic information systems (GIS) can be used to analyze and understand patterns, trends, and the spatial distribution of crime data and crime, such as muggings and burglaries [37,38]. The spatial data can be cross-combined with demographics or data of all kinds, e.g., mobile providers [39], and analyzed and visualized on a map, to identify hotspots where crime is most possible. This technique allows authorities and researchers to gain deep insights into crime patterns, plan preventive measures [40], and offer future prognoses [41], or take them into account while planning urban spaces [42].

Choosing a real-life, timely, and highly relevant topic from the field of GeoGovernment, or even further, geoinformatics, ensures that the students approach the problem highly motivated for various reasons. In a highly contextual and professional setting, they learn how to carry out complex spatial analysis and how to handle and enrich information and data. They also have the opportunity to acquire meaningful experience by using real crime data and GIS technologies needed in their future workspace, and in doing so, inherently improving their future job search outcomes. To keep this motivation high, we chose to use perhaps one of the simplest gamification mechanisms there is—splitting a group into two and having them compete against each other. One group, the "cops", was to identify the ATMs in Rhineland-Palatinate that are potentially at risk of being blown up in an attempt to prevent this from happening. The other group, the "robbers", was to determine the ATMs that were most suitable for demolition and jacking.

After the first lecture, during which the two groups were formed, a separate lecture was held for each group. As the students likely were not familiar with the usage of problem-based learning and game-based learning in teaching and learning, as the two forms of teaching are not usually used in their studies, we adapted the lecture to ease them into our approach. The procedure was not only presented in the first joint lecture, but it was additionally briefly repeated at the beginning of each separate lecture during the first three weeks.

As a framework, we used the seven steps of problem-based learning as proposed by [43] (see Table 1):

Table 1. Seven steps of problem-based learning [43].

Steps of Problem-Based Learning	Leading Questions	Goals
Step 1—clarify terms	What does this mean?	Clarify relevant concepts
Step 2—find subtopics	What is this about?	Subdivide the case, find core topics
Step 3—formulate hypotheses	What are you thinking about this?	Activate prior knowledge, find preliminary explanations or find answers
Step 4—order explanations	What do we think about this?	Discuss hypotheses, prioritize, structure
Step 5—formulate questions	What are the learning issues?	Review the case, find open questions from the group
Step 6—obtain information	What answers am I getting?	Acquire new knowledge
Step 7—exchange information	What is new, what changed?	Show, discuss, and secure knowledge

Following this, the first lectures (up to week four) during the semester were focused on a first problem analysis, activating existing knowledge. From lecture week five on, our focus was on facilitating self-study, in-depth problem analysis, and student-led reflection, all accompanied by feedback rounds with the supervising educator. As the course progressed and the students worked on their problem solutions, the subject matter that needed to be addressed, and subsequently, the course structure, changed dynamically. All this was accompanied by seven input sessions (see Figure 1). To prevent students from derailing from the planned track (i.e., problem solution), we incorporated two adaption loops in-between the course phases.

In the first weeks, the goal of the students, set by the lecturer, was to provide a schedule and concept for the approach chosen by the students. By providing input sessions starting from week five, it was ensured that the enrolled students learned and deepened the methods they would need to be able to arrive at a usable result in the course. The students had to take all available data on ATM burglaries in the state area and compile and process them. The input sessions by the instructor provided the foundation for this to be done properly. The data research and their subsequent fusion were carried out exclusively based on data that were freely accessible on the internet or available as open data on portals such as Presseportal [44] or OpenStreetMap [45,46]. Through the usage of data analysis tools, the educator then evaluated the obtained information iteratively through reflection and feedback rounds. By repeating phases two and three, combined with direct feedback from the educator, the students identified various data patterns and trends.

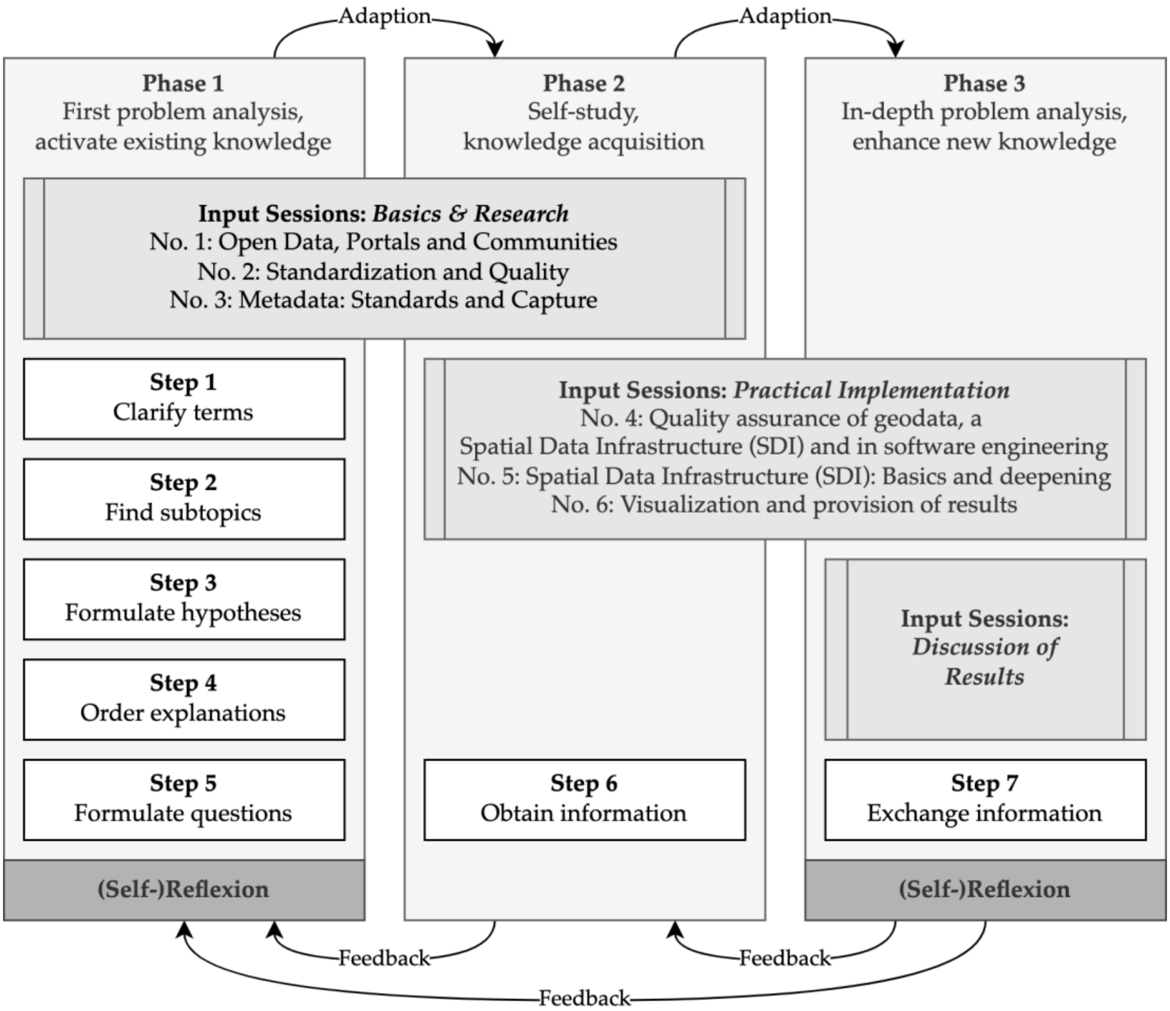

Figure 1. Structure of the course according to the three phases and seven steps of problem-based learning (based on [43]).

The students visualized the spatial data on different maps (see Figure 2) using open-source GIS applications. On the one hand, the police stations were visualized in relation to the blasted ATMs (see Figure 2a). Additionally, the isochrones were displayed to analyze the reachability times. Here, reachability within 5, 7.5, and 10 min was shown with different blue shades. In a next step, the distance between the nearest freeway accesses as well as exits and the ATMs was investigated (Figure 2b). Again, reachability was mapped using isochrones (different green shades). This resulted in a third figure (Figure 2c), which also uses isochrones to show which ATMs are not located near police stations and thus could potentially be more vulnerable. The students gradually approached a reachability analysis using spatial and temporal data.

The last lecture was a joint one, and students from both groups presented their results. It was noteworthy that each group of students was unaware of the details of the other group's developed method of the data-driven approach and its results until the final class. Thus, a certain tension and curiosity could be kept high until the project presentations.

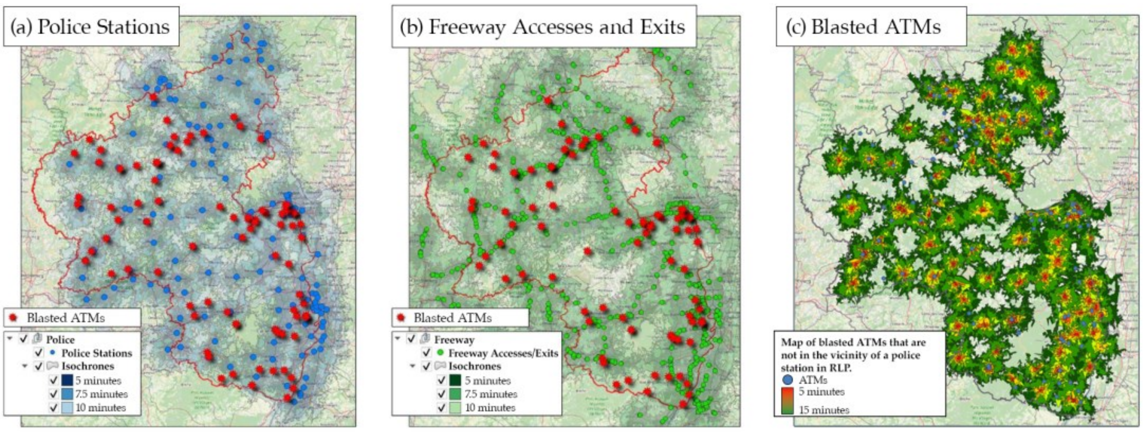

Figure 2. Student results as maps with spatially visualized data. The police stations are mapped on the left (**a**), the freeway accesses and exits are in the middle (**b**), and on the right there is a heatmap visualizing the ATMs that are not in the vicinity of a police station (**c**). (Background map: © OpenStreetMap contributors).

3. Results

Combining problem-based and game-based learning in conjunction with a current topic in the data-driven course helped the students familiarize themselves with scientific concepts, transfer their knowledge, and work out use cases for it, all while navigating a familiar, playful, but still highly professional environment. Additionally, it increased the students' interest and motivation, which is in accordance with the findings of empirical research. Through the targeted adaptation of the learning material and group work, it was also possible, at least in the semester of the course, to support students whose prior knowledge in the subject areas was not yet pronounced. This may be an effect of the approach being highly student-centered and the students identifying and learning the material they needed to move forward in finding a solution to their problem.

The weekly reflection and feedback rounds were relevant for the lecturer to assess the individual learning progress of the students and to maintain an overview of the overall group progress. This, and of course the group sizes, made it possible to address the individual needs of the people involved. On the other hand, focusing strongly and taking the role of a learning facilitator also have some drawbacks. Losing control over the learning outcomes is an unfamiliar role for an educator to be in, especially as the educator is traditionally expected to be the person responsible for achieving or enabling students to achieve those outcomes. Besides having to focus on the subject matter and possible problems in understanding the material at hand, the educator also has to anticipate possible social and motivational problems that prevent the students from achieving their goals and providing solutions to the defined problem. As a solution, we recommend checking the interim status of the group's progress through more frequent and more accessible mandatory consultations.

We also became aware of how difficult it is to maintain a balance using competition as a catalyst to boost students' motivation, which has had an impact on the students' motivation and interest, but could also easily set the focus of the course in the wrong way. When using game mechanics in an educational context, educators have to keep the end goal of their teaching in mind—facilitating effective learning experiences that will help students obtain their necessary knowledge and skills.

Retrospectively, the greater amount of time spent preparing the course must be mentioned. From the educator's point of view, it was a challenge to anticipate how the students would work on the problem while ensuring that the effort and the workload of the course remained within a reasonable time frame. One way of easing the strain which the educator has to take on when implementing an approach such as ours is outsourcing and digitalizing the organizational side, such as student communication through learning systems. As for future iterations of the course, we plan on using project management tools as a means to communicate with students and vice versa. By having an effective and easily accessible overview of the project status at all times, the educator does not have to allocate their time to questioning the students about it. Furthermore, by setting comprehensible milestones, the process is semi-automated.

As a side effect, upgrading to a digital platform enables the usage of a great number of other game mechanics, gamifying the course to an even bigger extent. Implementing reward systems, assigning points, and setting up leaderboards are functionalities that are pretty easily implemented in all the usual learning management systems (e.g., Moodle, OLAT, ILIAS). The downside could be focusing on extrinsic motivation while reducing the impact of intrinsic motivators. In future iterations of the course, we want to build upon more narrative-driven mechanics by implementing elements of storytelling. By being able to leverage the social effects of setting up groups to compete against each other, while still offering stories and "adventure paths" that can be perceived as unique by each student, we hope to address everyone accordingly.

At the end of the semester, we evaluated our approach, and the students said that they were motivated and, in retrospect, satisfied with the course, even if the time required was higher in comparison to other courses in the same semester. It needs to be said that the semester-end evaluation process lacked methodological rigor and heavily relied on subjective student opinions. To improve generalizability, we intend to propose an empirical approach for next semester, including random sampling and setting up objective student achievement metrics that are tested through pre- and post-assessments. Through this, we expect a more comprehensive and reliable assessment of the educational effectiveness of our approach.

However, during our evaluation, we observed some hesitation among students regarding the sharing of information with the instructor. There was a prevailing concern that the instructor might share this information with the other group. This fear possibly stemmed from the competitive nature of the groups. It is critical to address this issue in future courses to ensure open communication and trust between students and instructors. Establishing clear boundaries and ensuring confidentiality can help alleviate such concerns and foster a collaborative learning environment.

This can also be indicative of the problems when implementing gaming elements in a formal and usually very serious higher education context. While triggering a competitive spirit in students under normal circumstances would be a very positive thing to achieve, triggering it in such a way that they do not want to share information with tutors and educators because of "industrial espionage" is not a good result. The goal of educational experiences should be meeting the qualification goals and not winning a competition. To prevent this, possibilities of more open and transparent ways of communication need to be implemented.

4. Discussion

In this report, we explored the integration of problem-based learning, gamification, and data-driven approaches within the context of engineering education, specifically focusing on the "GeoGovernment 1" course in the Geoinformatics and Surveying degree program. These pedagogical strategies were implemented as a way to introduce and try out innovative teaching approaches that address several challenges faced by STEM education and try to decrease their impact.

The combination of problem-based learning, gamification, and data-driven approaches offered students a familiar and engaging environment to learn complex theoretical concepts and their practical implications. By working on a real-life problem related to ATM burglaries in Rhineland-Palatinate, students gained meaningful experience in handling and enriching data, conducting spatial analysis, and using GIS technologies. This approach not only seemed to motivate students, but it also improved their future job prospects by providing them with valuable, self-set skills. The course structure, including input sessions, problem analysis, and feedback rounds, facilitated student-centered learning and allowed for individualized support. However, it also required educators to take on a more facilitative role, which can be challenging in terms of maintaining control over learning outcomes. The use of competition as a motivational tool was effective, but required consideration to ensure that the focus on effective learning was not compromised. To counteract this, implementing more planned feedback loops is beneficial, especially in the early phases of the course (i.e., in steps 5, 6, and 7 of problem-based learning; see Figure 1).

Future iterations of the course plan to leverage digital platforms and implement additional game mechanics, such as reward systems and storytelling, to enhance student engagement and motivation.

In summary, the integration of project-based learning, gamification, and data-driven approaches in engineering education has the potential to address the challenges faced by STEM disciplines. It offers students an engaging and effective learning experience, while equipping them with valuable skills for their future careers in STEM fields.

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References

1. Rolwes, A.; Stellbauer, P.; Lungershausen, U.; Čubela, D.; Böhm, K.; Neis, P. MAATSE: Prototyping and Evaluating an Open and Modular E-Assessment Tool for STEM Education. In Proceedings of the 2023 IEEE 2nd German Education Conference (GECon), Berlin, Germany, 2–4 August 2023.
2. Kabilan, M.K.; Annamalai, N.; Chuah, K.-M. Practices, Purposes and Challenges in Integrating Gamification Using Technology: A Mixed-Methods Study on University Academics. *Educ. Inf. Technol.* **2023**, *28*, 14249–14281. [CrossRef]
3. Sukackė, V.; Guerra, A.O.P.D.C.; Ellinger, D.; Carlos, V.; Petronienė, S.; Gaižiūnienė, L.; Blanch, S.; Marbà-Tallada, A.; Brose, A. Towards Active Evidence-Based Learning in Engineering Education: A Systematic Literature Review of PBL, PjBL, and CBL. *Sustainability* **2022**, *14*, 13955. [CrossRef]
4. Zare, J.; Aqajani Delavar, K. Enhancing English Learning Materials with Data-Driven Learning: A Mixed-Methods Study of Task Motivation. *J. Multiling. Multicult. Dev.* **2022**, 1–17. [CrossRef]
5. Deterding, S.; Dixon, D.; Khaled, R.; Nacke, L. From Game Design Elements to Gamefulness. In Proceedings of the 15th International Academic MindTrek Conference Envisioning Future Media Environments, Tampere, Finland, 28–30 September 2011; Lugmayr, A., Franssila, H., Safran, C., Hammouda, I., Eds.; ACM: New York, NY, USA, 2011; pp. 9–15.
6. Dicheva, D.; Dichev, C.; Agre, G.; Angelova, G. Gamification in Education: A Systematic Mapping Study. *J. Educ. Technol. Soc.* **2015**, *18*, 75–88.
7. Hamari, J.; Koivisto, J.; Sarsa, H. Does Gamification Work?—A Literature Review of Empirical Studies on Gamification. In Proceedings of the 47th Hawaii International Conference on System Sciences (HICSS), Waikoloa, HI, USA, 6–9 January 2014; Sprague, R.H., Ed.; IEEE: Piscataway, NJ, USA, 2014; pp. 3025–3034.
8. Krajcik, J.S.; Czerniak, C.M. *Teaching Science in Elementary and Middle School: A Project-Based Learning Approach*, 5th ed.; Routledge: New York, NY, USA, 2018; ISBN 978-1-138-70004-8.

9. Prince, M.J.; Felder, R.M. The Many Faces of Inductive Teaching and Learning. *J. Coll. Sci. Teach.* **2006**, *36*, 14.
10. Kassen, M. Understanding Motivations of Citizens to Reuse Open Data: Open Government Data as a Philanthropic Movement. *Innovation* **2021**, *23*, 44–70. [CrossRef]
11. Xie, Y. *Is American Science in Decline? Online-Ausg.*; Harvard University Press: Cambridge, MA, USA, 2012; ISBN 978-0-674-06504-8.
12. Krutsch, E.; Roderick, V. STEM Day: Explore Growing Careers 2022. Available online: https://blog.dol.gov/2022/11/04/stem-day-explore-growing-careers (accessed on 5 November 2023).
13. acatech; Joachim Herz Stiftung MINT Nachwuchsbarometer 2023. 2023. Available online: https://www.acatech.de/publikation/mint-nachwuchsbarometer-2023/ (accessed on 5 November 2023).
14. Sithole, A.; Chiyaka, E.T.; McCarthy, P.; Mupinga, D.M.; Bucklein, B.K.; Kibirige, J. Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges. *High. Educ. Stud.* **2017**, *7*, 46–59. [CrossRef]
15. Seymour, E.; Hewitt, N.M. *Talking about Leaving: Why Undergraduates Leave the Sciences*; Westview Press: Boulder, CO, USA, 1997; ISBN 0-8133-8926-7.
16. Watkins, J.; Mazur, E. Retaining Students in Science, Technology, Engineering, and Mathematics (STEM) Majors. *J. Coll. Sci. Teach.* **2013**, *42*(5), 36–41.
17. Daempfle, P.A. An Analysis of the High Attrition Rates among First Year College Science, Math, and Engineering Majors. *J. Coll. Stud. Retent. Res. Theory Pract.* **2003**, *5*, 37–52. [CrossRef]
18. Markopoulos, A.P.; Fragkou, A.; Kasidiaris, P.D.; Davim, J.P. Gamification in Engineering Education and Professional Training. *Int. J. Mech. Eng. Educ.* **2015**, *43*, 118–131. [CrossRef]
19. Yasin, A.A.; Abbas, A. Role of Gamification in Engineering Education: A Systematic Literature Review. In Proceedings of the 2021 IEEE Global Engineering Education Conference (EDUCON), Vienna, Austria, 21–23 April 2021.
20. Souza, M.R.D.A.; Veado, L.; Moreira, R.T.; Figueiredo, E.; Costa, H. A Systematic Mapping Study on Game-Related Methods for Software Engineering Education. *Inf. Softw. Technol.* **2018**, *95*, 201–218. [CrossRef]
21. Su, C.-H. The Effects of Students' Motivation, Cognitive Load and Learning Anxiety in Gamification Software Engineering Education: A Structural Equation Modeling Study. *Multimed. Tools Appl.* **2016**, *75*, 10013–10036. [CrossRef]
22. Medienpädagogischer Forschungsverbund Südwest JIM-Studie: Jugend, Information, (Multi-)Media. 2022. Available online: https://www.mpfs.de/fileadmin/files/Studien/JIM/2022/JIM_2022_Web_final.pdf (accessed on 2 November 2023).
23. Su, C.-H. The Effect of Users' Behavioral Intention on Gamification Augmented Reality in STEM (GAR-STEM) Education. *J. Balt. Sci. Educ.* **2019**, *18*, 450–465. [CrossRef]
24. Thomas, J. A Review of Research on Project-Based Learning. 2000. Available online: http://www.bobpearlman.org/BestPractices/PBL_Research.pdf (accessed on 2 November 2023).
25. Solomon, G. Project-Based Learning: A Primer. *Technol. Learn.-Dayt.* **2003**, *23*, 20.
26. Krajcik, J.S.; Blumenfeld, P.C. Project-Based Learning. In *The Cambridge Handbook of the Learning Sciences*; Sawyer, R.K., Ed.; Cambridge Handbooks in Psychology; Cambridge University Press: Cambridge, UK, 2005; pp. 317–334.
27. Tan, O.S. *Problem-Based Learning Innovation: Using Problems to Power Learning in the 21st Century*; Cengage Learning: Singapore, 2003; ISBN 978-981-243-717-4.
28. Noordin, M.K.; Nasir, A.; Ali, D.F.; Nordin, M.S. Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in Engineering Education: A Comparison. In Proceedings of the IETEC'11 Conference, Kuala Lumpur, Malaysia, 16–19 January 2011.
29. Krajcik, J.S.; Czerniak, C.L.; Berger, C.F.; Krajcik, J.S. *Teaching Science in Elementary and Middle School Classrooms: A Project-Based Approach*, 2nd ed.; McGraw-Hill: Boston, MA, USA, 2003; ISBN 978-0-07-248674-2.
30. Walker, A.; Leary, H. A Problem Based Learning Meta Analysis: Differences Across Problem Types, Implementation Types, Disciplines, and Assessment Levels. *Interdiscip. J. Probl. Based Learn.* **2009**, *3*, 6. [CrossRef]
31. Barrows, H. Is It Truly Possible to Have Such a Thing as dPBL? *Distance Educ.* **2002**, *23*, 119–122. [CrossRef]
32. Hmelo-Silver, C.E.; Barrows, H.S. Goals and Strategies of a Problem-Based Learning Facilitator. *Interdiscip. J. Probl.-Based Learn.* **2006**, *1*, 4. [CrossRef]
33. Strobel, J.; van Barneveld, A. When Is PBL More Effective? A Meta-Synthesis of Meta-Analyses Comparing PBL to Conventional Classrooms. *Interdiscip. J. Probl.-Based Learn.* **2009**, *3*, 44–58. [CrossRef]
34. Galand, B.; Frenay, M.; Raucent, B. Effectiveness of Problem-Based Learning In Engineering Education: A Comparative Study on Three Levels of Knowledge Structure. *Int. J. Eng. Educ.* **2012**, *28*, 939–947.
35. Juergens, C.; Redecker, A.P. Basic Geo-Spatial Data Literacy Education for Economic Applications. *KN J. Cartogr. Geogr. Inf.* **2023**, *73*, 147–159. [CrossRef]
36. De Lange, N. *Geoinformatics in Theory and Practice: An Integrated Approach to Geoinformation Systems, Remote Sensing and Digital Image Processing*; Springer Nature: Berlin/Heidelberg, Germany, 2023; ISBN 978-3-662-65758-4.
37. Santos, R.B. *Crime Analysis with Crime Mapping*, 5th ed.; SAGE: Los Angeles, CA, USA; London, UK; New Delhi, India; Singapore; Washington, DC, USA; Melbourne, Australia, 2023; ISBN 978-1-07-183140-3.
38. Chainey, S.; Ratcliffe, J. *GIS and Crime Mapping*; Mastering GIS. Repr.; Wiley: Chichester, UK, 2006; ISBN 0-470-86098-7.
39. Bogomolov, A.; Lepri, B.; Staiano, J.; Oliver, N.; Pianesi, F.; Pentland, A. Once Upon a Crime: Towards Crime Prediction from Demographics and Mobile Data. In Proceedings of the 16th International Conference on Multimodal Interaction, Istanbul, Turkey, 12–16 November 2014.

40. *Crime Mapping and Crime Prevention*; Weisburd, D. (Ed.) Crime Prevention Studies; Criminal Justice Press: Monsey, NY, USA, 1997; Volume 8, ISBN 1-881798-08-9.
41. Almanie, T.; Mirza, R.; Lor, E. Crime Prediction Based on Crime Types and Using Spatial and Temporal Criminal Hotspots. *Int. J. Data Min. Knowl. Manag. Process* **2015**, *5*, 1–19. [CrossRef]
42. Wendt, W.; Exner, J.P. Crime Mapping for Urban Planning—A Useful Tool for New Planning Times? In Proceedings of REAL CORP 2014, Vienna, Austria, 21–23 May 2014.
43. Hammer, M.; Simon, S. Arbeitsmaterialien PBL Band1: Problembasiertes Lernen (PBL) 2019. Available online: https://www2.tuhh.de/zll/wp-content/uploads/01_PBL_Broschu%CC%88re_DRUCKDATEI_2019_04_01_web.pdf (accessed on 2 November 2023).
44. Die Plattform Für Pressemitteilungen Und Pressemeldungen | Presseportal. Available online: https://www.presseportal.de/ (accessed on 2 November 2023).
45. OpenStreetMap. Available online: https://www.openstreetmap.org/ (accessed on 2 November 2023).
46. Neis, P.; Zielstra, D. Recent Developments and Future Trends in Volunteered Geographic Information Research: The Case of OpenStreetMap. *Future Internet* **2014**, *6*, 76–106. [CrossRef]