Journal of Community Genetics (2024) 15:147–161
https://doi.org/10.1007/s12687-023-00692-6

RESEARCH

Wikipedia as an academic service-learning tool in science and technology: higher education case from Siberia

Ayla Arslan[1,2] · **Marko Turk**[2,3]

Received: 5 March 2023 / Accepted: 1 December 2023 / Published online: 21 December 2023

Abstract

Wikipedia, the open crowdsourced encyclopedia that anyone can edit, ranks among the top ten most-visited websites globally. Its integration into university curriculum as an innovative educational tool is a slowly growing trend; however, many higher education institutions have yet to fully grasp its potential. In response, a specific optional module for Wikipedia editing, designed for the selected undergraduate science courses at the School of Advanced Studies, Russia, was implemented as an optional extra credit service-learning activity, a teaching methodology combining meaningful service to the community with curriculum-based learning. Students who chose to participate and those who preferred not to participate in the activity were invited to participate in a research project to explore their perspectives and experiences. In total, five sessions of focus group discussions were conducted with participants (12 females and 2 males) in one set and non-participants (5 females and 4 males) in another to identify students' perspectives on themes such as their interest in science, reasons for their choices, and their expectations before the activity while post-experience focus group discussions were used to identify the perspectives of participant students on themes, encompassing contribution of the service-learning activity, acquisition of new skills, and the development of prosocial behaviors. Students' opinions on integrating social responsibility topics into the curriculum were also explored. The results extracted from these focus group discussions, analyzed through consensual coding, revealed factors promoting student participation, like interest in the subject, novelty of the activity, and grade improvement opportunities, as well as factors deterring participation, such as concerns about academic benefits, workload, and time constraints. Furthermore, the results demonstrated that Wikipedia editing serves as a novel teaching methodology, promoting student learning and development in digital literacy and information literacy, which are among the twenty-first-century skills. Interestingly, at the same time, not all students could address the value of contributing to open, crowdsourced knowledge for public service or interpret this activity as an academic service-learning. These suggest that Wikipedia editing is an innovative teaching approach, fostering students' learning and development while also indicating its potential to enhance students' understanding of responsible citizenship and public service in the digital age.

Keywords Wikipedia · Academic service-learning · Science education · Siberia case · Higher education · Twenty-first century skills · Public service · Biology education

Introduction

In an era where the integration of genetics, genomics, public health, technology and society is increasingly vital for improving communities (Lipworth 2019; Brand et al 2016), initiatives in these fields hold significant importance (Lemke et al 2022; Schmidtke and Cornel 2020). Fueled by the disruptive advancements of the fourth industrial revolution, including the developments in the life sciences and information technology (Bradu et al 2022; Pallen 2016), this has led to the evolution of dynamic and multifaceted landscape in genetics, genomics, and public health where different

✉ Ayla Arslan
ayla.arslan@uskudar.edu.tr; aylaarslan@yahoo.com

Marko Turk
marko.turk@par.hr; turk.marko1983@gmail.com

[1] Department of Molecular Biology and Genetics, Faculty of Engineering and Natural Sciences, Uskudar University, Istanbul, Türkiye

[2] School of Advanced Studies, University of Tyumen, Tyumen, Russia

[3] PAR University of Applied Sciences, Rijeka, Croatia

players, from commercial companies to social media, are contesting for attention, trust, and impact in shaping the field and its applications (Toussaint et al 2022; Gasteiger et al 2022; Basch et al 2021a; Basch et al 2021b; Schmidtke and Cornel 2020). Among these players, Wikipedia, the open crowdsourced encyclopedia, launched in 2001 (Stakić 2009), ranks as one of the top ten visited websites globally and the most visited website for reference materials/dictionaries and encyclopedias (Similarweb 2023). It goes without saying that students use Wikipedia widely, probably more than any other social group. For example, it was reported that Wikipedia is seen as a major health information resource in various settings not only for patients but also for the rest of society including students and physicians seeking health information online (Smith 2020). Given the common practice of students reading Wikipedia, why not encourage them to edit it? Approaching the study of biology, science, and technology through innovative methods such as Wikipedia editing could offer not only valuable opportunities for student development but also the potential to foster better-informed communities. In today's complex landscape of life sciences, technology, public health, and environmental concerns, this is becoming more critical than ever, especially in a climate of misinformation and false widespread beliefs (Crosswaite and Asbury 2016). For instance, despite significant progress in medical genetics and genomics, factors such as a lack of community engagement due to insufficient knowledge, poor communication, and language barriers continue to hinder access to genetic services among certain populations (Khan et al 2016; Adams et al 2015).

Academic service-learning (ASL), which finds its roots in experiential learning theory, stems from the holistic learning model of Kurt Levin, John Dewey, Jean Piaget, William James, Carl Jung, Paulo Freire, Carl Rogers, and others (Kolb 1984; Kolb and Kolb 2005). It might be referred to as a teaching methodology combining meaningful community service with curriculum-based learning (Kraft 1996). Increasing numbers of colleges and universities incorporate in a curriculum different form of ASL (Linares et al. 2021; Pérez-Ordás et al. 2021, Chrisman-Khawam and Manzi 2020; Horning et al. 2020; Chiva-Bartoll et al. 2020; Bringle and Hatcher 2000; Gasparis et al. 2017; Begley 2013; Ngai 2006; Ottenritter 2004). Studies show that an ASL-integrated curriculum is beneficial since it may increase student interest, facilitate curricular learning outcomes, professional skill acquirement, and cognitive development, and increase the sense of community engagement and social responsibility (Tanna et al. 2020; D'Alessio et al. 2021; Pilling et al. 2021; Bazzett et al. 2018; Webb 2017; Parsi & List 2008; Begley 2013; Yorio & Ye 2012; Groh et al. 2011; Cashman & Seifer 2008). This leads to the idea that contributing to open-source information through academic writing combined with digitization, as a form of community service, could potentially foster student development, exemplified by Wikipedia editing. In line with this, there is increasing awareness of Wikipedia editing for teaching purposes (Davis et al. 2023; Kahili-Heede et al. 2022; Moscovici et al. 2022; Romo and Rokop 2022; Rubin 2022; Stakić, et al. 2021; Ceballos, et al. 2021; Klein 2018; Apollonio et al. 2018; Sigalov and Nachmias 2017; Azzam et al. 2017; Burdo 2012; Chiang et al. 2012) while most academics are skeptical about Wikipedia (Jemielniak 2019). Thus, many higher education institutions have yet to fully grasp the potential of Wikipedia.

The present study, which explores the utilization of Wikipedia editing as a tool in biology, science, and technology education, presents the implementation and qualitative analysis of a Wikipedia-based ASL model designed for students enrolled in selected courses at the School of Advanced Studies (SAS), University of Tyumen, Siberia, Russia. SAS, established in 2017, places a strong emphasis on both teaching and research. The medium of instruction at SAS is English while the mother tongue for almost all students is Russian. However, for non-local international students, it is often another language. The ASL included the academic writing and/or translation of selected articles from English Wikipedia and the generation of a new Wikipedia article in the language of the student's mother tongue with the following aims: (i) fostering the students' learning of a specific subject by writing or editing the digital content of a selected Wikipedia article, (ii) advancing the skills of digital literacy, information literacy, and communication (and language translation skills), and (iii) nurturing prosocial behaviors and attitudes by increased awareness for responsible (digital) citizenship and public service due to service learning. By studying science and technology education through innovative approaches like Wikipedia-based service learning, this research indirectly fosters better-informed communities. Moreover, by detailing its application in a specific geographic context, such as Siberia, the paper has the potential to shed light on practices and challenges in regions with unique socio-cultural dynamics. Thus, this study possesses the potential to contribute significantly to the community genetics by bridging the gap between education and the practical aspects of life sciences, genetics, and public health within diverse communities.

Methods

Methodological approach

The research is based on a qualitative methodological approach conducted through focus groups. The implementation of Wikipedia-based ASL activity and associated focus group studies was divided into separate tasks, each

carried out individually by the authors. The focus groups were guided by a structured approach, based on a funnel model. This approach begins with broad questions and gradually narrows down to specific ones, covering various thematic areas for discussion (Grunig 2008).

Sampling

Before the research started, researchers got institutional ethical permission, and students were introduced to informed consent for research participation. These students, the second- and third-year students who either take the "Science and Technology" or the "Unit of Life" in the School of Advanced Studies (SAS), University of Tyumen, Russia, were given an optional assignment for editing a selected Wikipedia article. For data collection, the students got their codes without their names or initials to ensure anonymity. The same codes were used in the citations of the research participants' answers with the letter P for participants who signed up for the Wikipedia-based ASL assignment and took part in the focus group discussions and NP for non-participants, who did not take the assignment but took part in the focus group discussions. Out of 52 students, 24 students (P) took the assignment and 14 of them joined the focus group discussions, while among the 24 students (NP) who did not take the assignment, 9 students took part in the focus group discussions. Thus, a total of 23 students (17 females and 6 males) (Table 1) were engaged in five sessions of focus group discussions. The target sample was used based on the researchers' decision about sample typicality (Cohen et al. 2000). Furthermore, researchers considered the importance of focus group homogeneity, which is "... essential for group interaction and dynamics." (Grønkjær et al. 2011, p. 23). As also summarized in Table 1, the homogeneity of research participants was fulfilled through these elements: (i) all participants were second-year students from the Science And Technology class, (ii) with the same experience of participation in the assignment.

ASL assignment

The ASL activity was introduced as a Wikipedia editing assignment aiming for the introduction and implementation of the Wikipedia editing assignment. This was based on four pillars: (i) vision and goals, (ii) strategy and team building, (iii) teaching and implementation, and (iv) reflections. In the first week, students were introduced to the Wikipedia editing assignment, including the vision and the goals. The assignment was delivered according to a specific strategy that the students were divided into five teams, each consisting of 5–6 students. Students were encouraged to choose their topics in consultation with the course professor and fostered student-centered learning of "Wikipedia Basics" such as accessing the information, evaluating information, and creating information. Besides, teams were regularly instructed according to a 4-week plan during which each team had a special consultation with the course professor on a weekly basis that students were further facilitated for finding reliable sources, reading, drafting, consultation, and rewriting. Students also compared the relevant Wikipedia content in English and in their preferred Wikipedia editing language. These activities took place after the regular class hours and lasted about 3 h per week of the professor's office hours for about 20–30 min for each student groups. Often students were also asked to schedule and conduct expert interviews (consultation) in their subject when necessary.

Data collection and analysis

Five focus group discussion sessions were conducted. This included one focus group discussions for nonparticipants and four for participants. Thus, one pre-experience and three post-experience of participants' focus group discussions were conducted before and after the ASL activity, respectively. The group discussions were audio recorded and transcribed (Express Scribe Professional software from NCH Software, USA).The transcripts were checked to assure accuracy then thematically analyzed by the consensual coding method (Merriam 1998; Creswell 2014). The details of the data collection and analysis are given in below sections.

Table 1 Characteristic of students who participated or did not participate in the optional Wikipedia-based ASL activity. Among these students who took part in the focus group discussions are shown as bold together with the focus group codes in parentheses (F, female; M, male; P, participant; NP, nonparticipant; FG, focus group)

	Course name/year	
Number of students	Science and technology/2	Unit of life/3
Total	47 (34 F, 13 M)	5 (4 F, 1 M)
Participant (P) students	23 (20 F, 3 M)	2 (1 F, 1 M)
Nonparticipant (NP) students	24 (14 F, 10)	3 F
Nonparticipant students in the Focus group study (NP/FG1)	**9 (5 F, 4 M)**	None
Participant students in the focus group studies (P/FG2, P/FG3, P/FG4, P/FG5)	**14 (12 F, 2 M)**	None
Participant and nonparticipants in focus groups	**23 (17 F, 6 M)**	None

The focus group discussions were built to evaluate the impact of the ASL assignment descriptively in terms of the learning outcomes:

- Practicing and delivering a new topic related to the course subject
- Acquiring and advancing the skills of information literacy, digital literacy, and communication

In addition, the increased motivation and interest in science and technology topics, besides developing a sense of social responsibility as digital citizens, was also considered. Thus, this research has been conducted to understand students' learning and development, how students perceive and understand Wikipedia editing assignments as ASL, and how they reflect on participation in ASL activity. The results shall be presented in this paper. As an added value, this research also promoted ASL among students who need to be aware of the concept and in the institution where ASL has not been implemented in the curriculum.

Focus group topics for discussions were grouped into three areas of questions. The first group of questions was designed for nonparticipant students (NP/FG1,Table 1) to identify their perspectives on key themes, with a focus on the students' interest in science, the reasons for not participating in the ASL and opinions on social responsibility topics in a curriculum. The second group of questions were designed for participant students' perspectives before ASL activity (pre-experience). These questions were directed in focus group discussions conducted through P/FG2 (Table 1). The questions were aiming for identifications of perspectives on key themes, with a focus on the students' interest in science, the reasons for their choices, and their expectations. The third group of questions was dedicated to the examination of post-experience perspectives, in three sessions of focus group discussions (P/FG3, P/FG4) P/FG5) encompassing the contribution of participating in ASL activity, the acquisition of skills, and the development of prosocial behaviors and attitudes. Furthermore, the question of social responsibility and its integration into the curriculum was addressed (opinions about social responsibility topics in a curriculum). The themes and questions asked to each focus group are given in the Supplementary Material 1.

All focus group discussions were audio recorded, and in the second phase, the recordings were transcribed using Express Scribe Professional software from NCH Software (USA). Additionally, manual checking was performed by the author (who conducted the focus group sessions) to ensure the accuracy of the transcriptions. Based on the first phase of "pure" transcription, in the second phase, consensual coding (Merriam 1998; Creswell 2014) was conducted by both of the authors. The themes, patterns, and codes within the qualitative data were identified and agreed upon by working separately and together. Specifically, during the analysis process, a portion of the data was independently coded, and then, codes were compared. Any discrepancies or disagreements were discussed and resolved through consensus-building discussions. Also, regular meetings were held by the authors to review the coding process, compare interpretations, and discuss emerging themes. Through these discussions, the aim was to refine and validate the coding process. The coding process was utilized to analyze and categorize data to identify patterns, themes, and concepts within the dataset. A thorough familiarization with the data was initiated involving the reading and re-reading of transcripts and notes to understand the content comprehensively. In the initial open coding stage, the data was broken into smaller, more manageable units. These units were phrases, sentences, or paragraphs that captured a single idea or concept. In the second axial coding phase, connections between codes were established. This involved organizing codes into broader categories and subcategories. After that, categories were further refined, and core categories that captured the essence of the data were selected. The coding process was completed when the point of data saturation was reached, where new data was no longer contributing significantly to understanding the research topic. It is essential to emphasize that detailed memos were kept throughout the coding process to document thoughts, insights, and reflections about the data, the codes, and emerging patterns (Creswell 2014). Furthermore, new data was continuously compared to previously coded data during the coding process to ensure that the emerging categories and themes remained consistent and accurate, which resulted in the thematic data tree. The thematic data tree is shown (Fig. 1) and used for further results presentation and discussion.

Results

Overview

The study design allowed for comparative focus group analysis between participants and nonparticipants, as well as analysis of participants for their pre- and post-experience perspectives. The data collection of the study lasted for a period of 5 weeks with three distinct stages as shown in Fig. 2**.** These stages encompassed the experience of ASL assignment itself along with pre- and post-experience focus group discussion sessions. The pre-experience stage, which took place in the first week, involved two categories of students: those who chose not to participate in the ASL assignment or nonparticipants and those who chose to take part in the ASL activity, or participants. From these categories, participants were recruited to form two separate focus groups, the first comprising non-participants (NP/FG1) and the

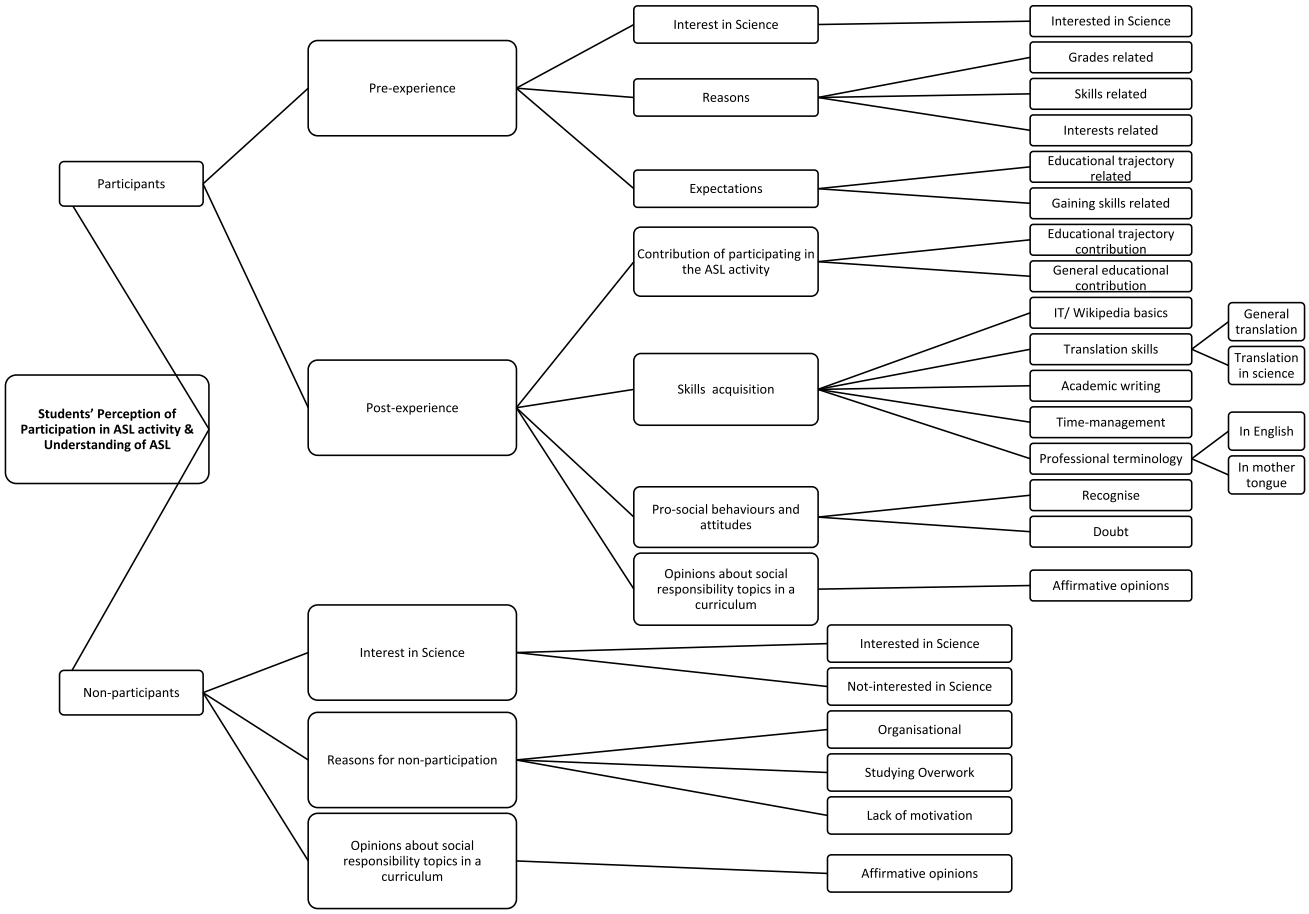

Fig. 1 Data tree obtained from focus group discussion sessions

second consisting of participants (P/FG2) (Fig. 2). Results of this pre-experience stage focus group discussions are presented in the below sections "The profile of nonparticipant students" and "The profile of participant students." The ASL stage was the second stage, during which participant students (P/FG2) were introduced to the Wikipedia editing assignment (Fig. 2). Following this, in the post-experience stage, the participant students were introduced to three focus group discussion sessions. The results of this stage are presented in the section "Students' experiences after the ASL activity."

The profile of non-participant students

A single focus group discussion session (NP/FG1, Fig. 2) was conducted among students who preferred not to participate in the optional Wikipedia-based ASL activity. The discussion addressed three major themes: interest in natural and applied sciences (N&AS), reasons for non-participation, and opinions about social responsibility topics in the curriculum. In the analysis of non-participant students' views about their interest in N&AS, it was observed that in this group, opinions were not unanimous. This group of non-participant (NP) students (S) displayed diverse perspectives, which can be categorized into those who were interested in N&AS and those who were not.

> I am especially interested in N&AS, particularly in biology. (NP, S1)
> I am especially interested in zoology, particularly animal evolution. (NP, S2)
> Ever since I was 8, I have been interested in N&AS. I played with laboratory sets and games. I was especially interested in chemistry and biology in school, even though my teachers weren't very encouraging and supportive. (NP, S6)
> I enjoy N&AS. It was my main interest in primary and high school. Among others, I am interested in biology and computer science. (NP, S11)
> I genuinely enjoy biology, but I am not sure if N&AS are my field of interest. I am primarily interested in education. Also, I am interested in film studies because it correlates with my non-academic interests (hobbies). (NP, S5)

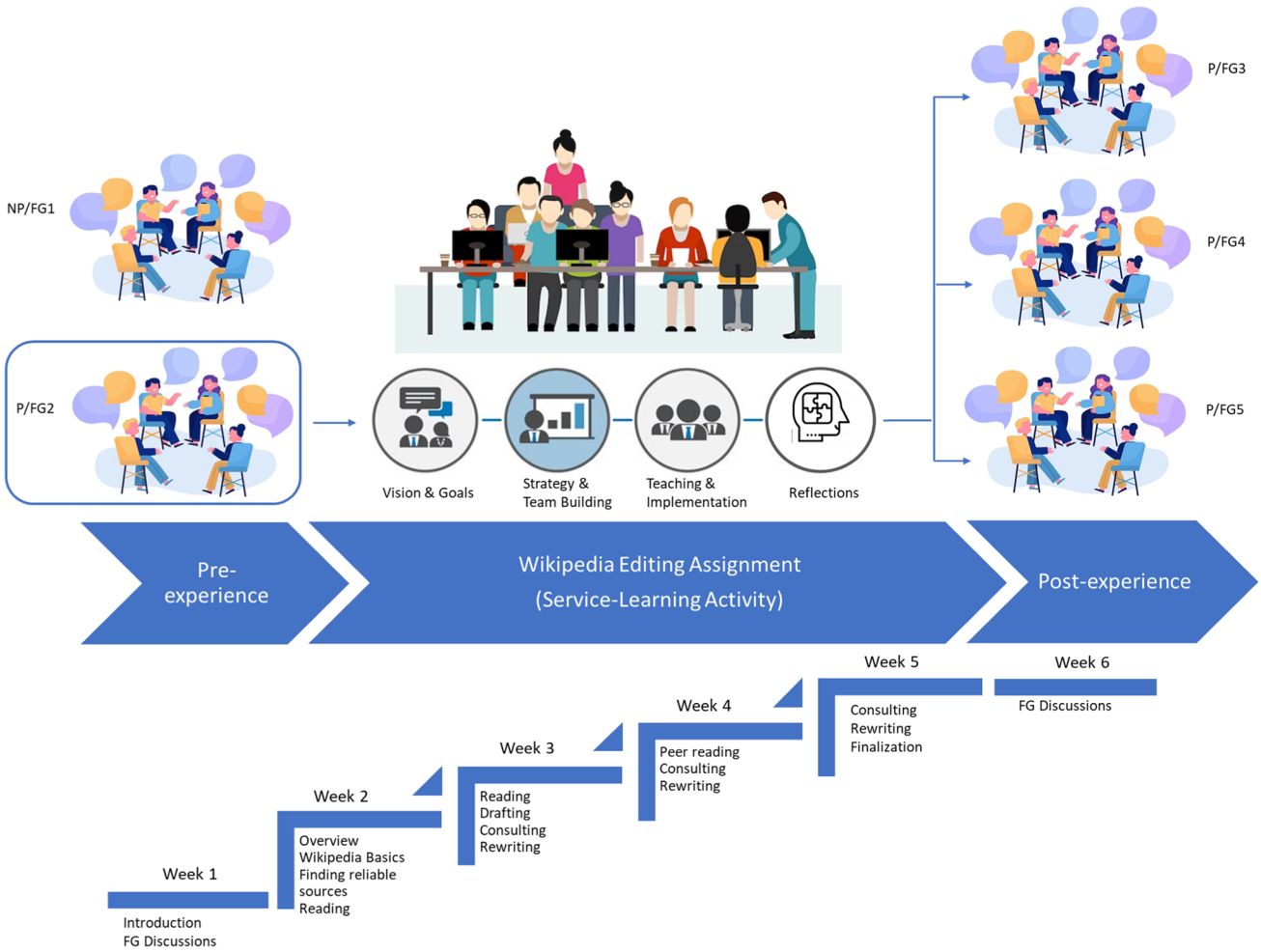

Fig. 2 The study lasted for a period of 5 weeks with distinct stages and components. Pre-experience and post-experience stages represent the periods at which focus group analyses were conducted. In between, Wikipedia-based service-learning activity was instructed and implemented. The first focus group discussion was dedicated to the insights from the nonparticipant students (NP/FG1). This focus group had 5 females and 4 males, a total of 9 students. The second focus group discussion was dedicated to pre-experience perspectives of participant students (NP/FG2), while three additional focus group discussions were arranged for these students to identify their post-experience perspectives (NP/FG3, NP/FG4, NP/FG5). These four focus group discussions of participant students had 12 females and 2 males, a total of 14 students (human icons were obtained from Freepik, October 2023)

I am not sure if I am interested in N&AS. I don't see N&AS as something exciting and inspiring for discussion. Furthermore, as an important issue, I see language boundaries since we studied N&AS in English. (NP, S6)

Natural and applied sciences tickle my curiosity, but I don't like to go in-depth because they are not the focus of my interest as humanities are. I made that distinction in middle school because I had excellent humanities and social sciences teachers, and they triggered my interest in humanities. (NP, S10)

My academic interest is not in natural sciences but in humanities, psychoanalysis and anarchist studies. I was interested in natural sciences in my middle school; unfortunately, my teachers killed that interest with their approach and teaching styles. (NP, S8)

The next theme discussed during the focus group study was the reasons for not participating in the ASL activity (reasons for their choices). Results show that students had various reasons, which might be grouped into three content-related groups:

1. Organizational and personal reasons

I missed the deadline. (NP, S1)Because I don't like professors who teach N&AS at our institution. (NP, S2)This activity requires too much work. That's why I didn't choose it. (NP, S8)

2. Studying overwork
Lack of free time and course overload. I would like to participate but my current situation doesn't allow me to participate because I don't want to sacrifice my studies. (NP, S4)Because I am overwhelmed with studies and I have my part-time job and can't participate in everything the institution offers. (NP, S9)Because at that time I felt depressed because of other professors' feedback and all my studies and didn't have energy for anything. (NP, S7)

3. Lack of motivation
Because I don't see any concrete reason for how this activity might improve my skills. (NP, S10)I didn't find it interesting for me and my further academic development. (NP, S3)I don't think it is an activity which might improve something globally and I don't think that I would enjoy it. (NP, S6)

The course workload and lack of time appear to be an effect on nonparticipants. Besides, when students tend to fail to find any benefit for their academic development, they seem to prefer not to take the assignment.

The third theme discussed with students was related to their opinions about social responsibility topics in a curriculum. The non-participant students were unanimous about the importance of social responsibility in the higher education curriculum.

Yes, because making science not an isolated part of the world but something which might contribute to society and share with the broader community. (NP, S7)
Absolutely, because that is the way we improve our society and country. (NP, S10)
Yes, since we need to be more aware what is going on around us, not just focused on classics. (NP, S12)

The profile of participant students

The pre-experience focus group attendees (Fig. 2, P/FG2) were recruited from 25 participant students (20 females and 3 males from the Science and Technology class and 1 male and 1 female from Unit of Life class). Thus, 14 students (12 females and 2 males) preferred to take part in the focus groups discussions. These 14 students were all second-year students in the Science and Technology class, and they were expected to select their academic track or major at the conclusion of their second year.

During focus group discussion sessions, three major themes were tackled: interests (in science), reasons, and expectations; thus, they were asked about their interest in Natural and Applied Sciences (N&AS) as an academic subject, their reasons for deciding to participate in the ASL activity, and their expectations from ASL activities in the context of their educational trajectory, as well as the context of acquiring new skills.

In order to identify if the course subject had an impact on students' preferences for the participation in the ASL activity, students were asked about their interest in N&AS. Following the data tree in Fig. 1, results show that this group of student (S) participant(s) (P) is unanimous about their interest in science consistently, a trend which was not identified in the first focus group analysis described in the previous section. In other words, they showed higher levels of interest in science, emphasizing the following:

I'm interested in physics because of its applicability and how we connect physics with everything we live in. I found that I liked N&AS when I entered university. (P, S1)
N&AS are my main interest especially those sciences which explain human behaviour. I would be interested that my future work might help people to improve their life. (P, S4)
I am interested in biology, especially animals and vet medicine. My interest in N&AS started when we started to learn anatomy. All in all, I would say I'm interested in the interdisciplinary field of marketing behaviour and biology. (P, S8)
I've always been interested in N&AS, but I also enjoy S&H. However, my preferences are based on my family context because my mother is a medical doctor and my father a chemist. Still, I can't say that N&AS are more attractive to me. (P, S11)

When the students were asked about their reasons for choosing the Wikipedia editing assignment. Their answers might be grouped into three thematic content groups.

1) Grade-related reasons

Bonus grades at the beginning, but when I started to look for wiki articles, I've found it interesting, and I can learn something new. Also, it helps me to practice my translation skills. (P, S1)

Initially to enhance the grade but also I was thinking about my cousin who is studying medicine and doesn't have literature in English. (P, S4)
Because I'll get additional points. (P, S19)

2) Skills related reasons

I think I can learn something new. (P, S12)

It's cool to have your own Wiki page. It's a good experience to investigate different learning possibilities and gain new skills. (P, S16)

3) Interest-related reasons

> Because of my interest to try something new. I've never done anything like this. At the same time I wanted to discover a new thing but also to participate in SL activity. (P, S7)

> It sounds interesting for me to be part of some project and to be part of something which is new at our institution. (P, S8).

The opportunity for grade improvement due to the assignment was important for students and learning something new in a new learning environment. Furthermore, it was interesting to notice that a bonus grade was the initial motivation for some students. However, while participating in the ASL, they discovered how it might be helpful for their relatives and other students. It might be said that students found and brought to consciousness the ASL voluntaristic element, which might be interpreted as a crucial added value.

Following the discussion on the theme of students' reasons, the discussion of the third theme, the students' expectations from the assignment was conducted. Results showed that students had two potential prospects: (1) the potential of the assignment to contribute to their educational trajectory (ET) and (2) the potential of the assignment for the development of different skills. Thus, there is some degree of overlap between the students' reasons and expectations in terms of skills acquisition, but in general, the reasons for participation and expectations are different. This suggests that the motivation (reasons) and expectations are not aligned fully. Students showed that their expectations are much more focused on developing different, broader academic and non-academic skills than on their educational trajectory, especially in science. Since Science and Technology was a core course, it was required to be taken by all students before they chose a major (educational trajectory): Information Technology, Cultural Studies, Life Sciences, Economics, Film and Media Studies, History, Sociology and Anthropology. Students did not think the assignment would benefit their "educational trajectory" or academic pathway.

> Not going to help me much in terms of ET in biology but it's interesting to learn something new. I think going to the library and learning something new from there will be beneficial. Competencies in terms how Wikipedia is functioning - IT skills. (P, S1)
> This experience will heat up my interest in the topic I'll investigate. Also, I like this old-fashioned approach to go to the library and read materials. Also, interdisciplinary knowledge as a part of competencies and argumentation skills. (P, S2)
> Will help me with my translation skills. Knowledge for general academic development (to know more about different disciplines) of my professional personality, writing and translational skills. (P, S3)
> It wouldn't help me in my educational trajectory, but I'll improve my academic and writing skills in the Russian language because we are not learning how to write academically in our mother tongue. In terms of competencies, I think that linguistic competencies will be developed. (P, S6)
> Emphasizing interdisciplinarity. I think I will develop my organizational skills and gain some knowledge in academic writing. (P, S10)
> It won't really help me in my educational trajectory but it is an interesting experience in terms of how to translate articles, how to write and so on. (P, S13)
> Writing skills and searching for reliable information. Also, writing skills in Russian language, so I think it's good. Also an attitude how I can help someone from the general audience to understand scientific language. (P, S14)

From the students' answers, it was evident that they expected to acquire new skills, including writing, language translation, and organizational skills, in addition to their subject knowledge. Interestingly, some students were able to anticipate the benefits of the assignment in a deeper context:

> …searching for reliable information… (P, S14).
> …Also, I will develop my research competencies and academic responsibility in terms we have to think about what we write publicly and not some information which is not confirmed and scientifically checked. (P, S4)

These students' statements confirm one of the assignment's learning goals, which pertains to information literacy skills (categorized under Academic writing and Wikipedia Basics in Fig. 1). However, most students were unable to anticipate this aspect during the focus group discussions conducted before the ASL activity (as shown in Fig. 2, the pre-experience stage).

Students' experiences after the ASL activity

The ASL activity revealed the diverse interests of 26 participant students in their chosen Wikipedia editing topics, ranging from "Do-it-yourself biology" to " Genetic epidemiology," "Psychiatric medication" and "Bioethics," as evidenced by the copy of the collaborative online spreadsheet filled out by students (Table 2). From this group of students, the attendees of the focus group (12 females and 2 males) tackled the questions to address students' experiences relevant to themes of contribution of ASL activity, skills acquisition, prosocial attitudes and behaviors, and the

Table 2 Topics and language chosen to be edited by students who preferred to participate in the Wikipedia editing assignment. The topics are ordered according to original student entries in the online collaborative spreadsheet

Topics chosen by students	Language of editing
Divided consciousness	Russian
Hazards of synthetic biology	Russian
Bioethics	Indonesian
Ecomodernism	Russian
Do-it-yourself biology	Russian
Psychiatric medication	Russian
Brain-reading	Russian
Retinohypothalamic tract	Russian
Knockout mouse	Russian
Praya dubia	Russian
Genetic epidemiology	Russian
Technology assessment	Russian
Emerging technologies	Russian
Impact of COVID-19 on neurological outcomes	Russian
Genopolitics	Russian
Functional neuroimaging	Russian
History of biotechnology	Russian
Future food technology	Indonesian
Neuroscience of sex differences	Russian
d Subunit GABA (A) receptors	Russian
Cortical homunculus	Russian
Biotechnology risk	Russian
Our post-human future	Russian
Science wars	Russian
Social construction of technology	Russian
Anticipation (genetics)	Russian

question of socially responsible science, citizenship, and its support and encouragement.

In the discussion about the contribution of the ASL activity (Fig. 2, P/FG3), it might be said that students' answers covered two directions. The first direction is one in which they clearly stated that they do not notice the contribution of the ASL activity to their educational trajectory, while at the same time, in the second direction, they strongly emphasized general educational or academic contribution. This is clearly visible from students' answers:

> Has not contributed to my edu trajectory in science in particular but stimulated my interest in being editor in Wikipedia. So, It was interesting to me to enhancing and expanding my knowledge in that matter. (P, S1)
> I don't think that SL activity didn't contributed to my educational trajectory but it helps me to understand how the site (Wiki) works. (P, S2)
> For educational trajectory in science not, but as a general educational experience it was useful. (P, S11)
> I wouldn't say it contributed to ET in science but as a general educational experience was incredibly useful. (P, S12)
> I don't think it has affected my educational trajectory and it was quite complicated to me to think about these scientific things but it was interesting to me to participate in this type of the project and these activities might be handy in the future. (P, S14)

In parallel with "the contribution of participation in ASL activity," students expressed the acquisition of new skills or in broader sense, the competencies. Students' specifically underlined acquiring IT/ Wikipedia managing and information literacy (finding the reliable sources, editing the content and citing appropriately the reliable sources) skills and translation skills as benefits but also particularly emphasized translation in science, skills related to academic writing, and time management. Moreover, they stressed the acquisition of professional terminology in English, Russian, and Indonesian, for example.

> As for knowledge and skills, I found some html codes in Wikipedia. Moreover, I found out how to do references in different ways. As for attitude, it makes me curious, and I want to do more. (P, S1)
> I improved my translation skills, especially in science. Also it helps to distinguish types of information, which are important and which are not crucial for the reasoning. (P, S2)

> I improved time-management and prioritising assignments. (P, S4).

> How to make references and how to create pages on Wikipedia. I learnt how to look at a specific topic from a different perspective (historical, present and future). Also, the importance of peer review helps me. For instance, my mother, as an expert in the field, helped me a lot. (P, S5)
> Translation skills, I learned professional terminology in English and Russian, I acquired the skill of data management and scientific content. (P, S11)

On the theme of pro-social attitudes and behaviors, which was discussed in the final postexperience focus group session (P/FG5, Fig. 2), students' views on Wikipedia editing as an assignment that gives the opportunity for community service (such as increasing the content/quality of open information, increasing the language diversity) and thus as an activity for responsible citizenship were mixed and opposing. Regarding this, focus group interview transcripts of students describe their experiences and opinions on service learning that might be subsumed under two categories: (1) students who doubt pro-social attitudes and behaviors as a result of Wikipedia editing and (2) students who recognize

pro-social attitudes and behaviors as a result of Wikipedia editing.

> I think that this activity wasn't a real service-learning activity because we don't know to whom we are helping and what specific group of people really need it. I didn't feel I was helping people. (P, S2)
> It is a bit controversial because I don't know how much I help the society (P, S3)

On the other hand, some students had different opinions:

> I understand the importance of that activity. I opened some new horizons for other people who don't know English. (Editing Wikipedia in Russian) (P, S5)
> I understand that it's important to be helpful to other people. This activity showed me I can be helpful for people not being in contact with them. I've learnt I can use devices to help people and I will do so in the future. (P, S6)

In parallel with the opinion of nonparticipant students, participant students' focus group discussion (Fig. 2, P/FG5), regarding the opinions about social responsibility topics in a curriculum, were consistent. They all expressed it as an important dimension of education.

> For sure, because that is the way we improve our broader views in education. (P, S5)
> Yes because it gives people more information and views about some social problems which we can't get only from scholarly written books. It's not everything about classics, it's much more about real people. (P, S6)
> Personally, I believe that these activities are crucial in the curriculum because they provide us with a broader insight into the world and real problems in the local community. (P, S10)
> It is absolutely necessary to include them. Why? Because it is a reality. Reality is not something that happened in the 5th century. (P, S12)

However, there were some concerns about the way it should be included in the curriculum. For example, it was stated:

> Should be included, encouraged, praised but not forced or mandatory because students might be repelled from that activity. (P, S1)
> I really appreciate activities like this and I think there should be more. What is crucial is that they should be elective. (P, S13)

Thus, the inclusion of social responsibility and community service in curricula appears to require special consideration for not being mandatory besides other concerns, such as the context of social engagement and grading as expressed by the students. However, students were clear about the importance and recognition of social responsibility in a curriculum which is valuable input for curriculum creators in the (Russian) higher education system.

Discussion

In the present study, qualitative analysis of the student opinions on an optional module for Wikipedia editing, implemented at the School of Advanced Studies, University of Tyumen, Russia, is described. This module, part of "Science and Technology" and "Unit of Life" undergraduate courses, was incorporated as an extra-credit service-learning activity. The students were categorized as participants and non-participants. Following the recruitment of focus group attendees from this pool of students, perspectives of students were examined through five focus group discussion sessions, concentrating on seven different themes before and/or after the Wikipedia-based ASL activity. The primary objective of the study was to determine how this assignment facilitated student development and encouraged pro-social behaviors and attitudes through service learning. Our results show that the opportunity for grade improvement, acquiring of new skills, and novelty of the activity were among the reasons for student preference for taking the optional Wikipedia-based ASL assignment. Specifically, when comparing nonparticipants with participants, it becomes evident that the course subject plays a crucial role in students' choice to engage in a Wikipedia-based ASL assignment. Additionally, the study of non-participant students reveals that the overall course workload and a lack of time seem to influence their choice not to participate in ASL. Furthermore, when comparing non-participant students with participant students, we found that if students do not perceive any academic benefits, they are more inclined to avoid taking on the assignment.

In general, a gratifying and positive student experience due to participating in the activity was the result of our study, which is in line with similar studies conducted in Wikipedia-based teaching (Apollonio et al. 2018; Azzam et al. 2017; Chiang et al. 2012; Burdo 2012) . While further research is needed to assess student learning (Maggio et al. 2020), our findings show the key benefits from a student perspective: communication skills, digital literacy, and information literacy. These results align with the literature findings suggesting that communication skills, digital literacy, and information literacy, such as the ability to locate publicly available reliable sources, convey digital information clearly, and analyze and condense primary literature, are the benefits of Wikipedia editing assignments (Kahili-Heede et al. 2022; Ceballos et al. 2021; Maggio et al. 2020; Apollonio et al. 2018; Azzam et al. 2017; Burdo 2012; Chiang et al. 2012). However, whether the assignment improves students'

overall writing skills remains a question (Burdo 2012), a factor we did not address in our study. Additionally, our analysis revealed that there was a clear emphasis on the idea that students did not consider the benefits of Wikipedia-based ASL activity as a contribution to their educational trajectory. These results suggest that Wikipedia editing presents an exciting new learning opportunity for university students, fostering their learning and promoting the development of twenty-first-century skills, particularly information literacy and communication, which can be considered foundational. However, in our case, it seems that students did not have a holistic perception of their learning experience and curriculum. They appeared unaware that the learning of specialized educational pathways depends on their foundational education. This underscores the importance of nurturing students' understanding of their curriculum and addressing how the learning outcomes of each course contribute to their educational journey within the curriculum. Furthermore, it emphasizes that curriculums in higher education should not solely focus on achieving learning outcomes based on academic content. They should also incorporate activities and tasks that impart social responsibility and an understanding of societal needs.

Another aspect of our Wikipedia-based ASL module relates to its "service" dimension in the service-learning activity. Voluntary community service, as a proactive expression of social responsibility, where individuals or organizations take it upon themselves to make a positive impact on their communities, is crucial. In a time when the convergence of life sciences, genetics, and technology is becoming ever more essential for enhancing public health and dealing with ethical, legal, and societal matters, our educational program holds significance for advancing these matters. This prompted the questions about the position of "service" within the university curriculum. Moreover, we inquired whether Wikipedia-based ASL, as a form of community service, enhanced students' sense of social responsibility. Both participant and non-participant students were unanimous about the importance of curricular emphasis on community service as a manifestation of social responsibility. More broadly, students were clear about the importance and recognition of social responsibility in a curriculum, which provides valuable input for curriculum creators in the (Russian) higher education system.

However, students also expressed a special concern about the status of social responsibility, indicating a preference for it not to be mandatory, among other concerns, such as the context of social engagement and grading. Indeed, while curricular integration of social responsibility is considered important, our study showed that not all students were able to identify the Wikipedia-based ASL activity as community service, relevant to social responsibility. Basically, the idea of better-informed communities by contributing Wikipedia as a meaningful community service was not clear for all students. For some students, the lack of direct social interaction was perceived as a requirement for a sense of social responsibility. Interestingly, the university students in the 2020s are born into world of digital societies; they spend a considerable time in social media globally with the younger generation spending more time (Buchholz 2022; Saha and Guha 2021; Rideout 2015), and students in Russian higher education institutions (HEIs) are no exception. For instance, research shows that students from the Russian State University for Humanities used social media not only for socializing but also when deciding on HEIs abroad (Rekhter and Hossler 2020) . This shows that—at least in our case—while students widely use social media and are highly engaged in digital platforms in general, they do not necessarily couple it with other social aspects such as social responsibility and community service. Thus, our results emphasize a conflict that exists between the common use of social media without awareness for its horizons. This conflict highlights an opportunity as well, as it suggests that preparing the students for the twenty-first century can be achieved by the Wikipedia editing assignment, designed as an ASL with additional emphasis on digital society and responsible citizenship.

The service-learning dimension of the Wikipedia editing assignment has been the focus of several other studies (Kahili-Heede et al. 2022, Moscovici et al. 2022; Azzam et al. 2017). These studies reported that the students found the task meaningful and impactful on society. Even though qualitative analysis does not discuss results based on quantifying elements of research participants, it should be noted that in our study, only a few students identified the Wikipedia-based ASL activity as meaningful and impactful on society. This shows the importance of social, cultural, psychological, cognitive, and other aspects of teaching and learning that could play a role in student perception emphasizing the significance of personalized approaches when designing Wikipedia-based ASL activity. The utility of assessment, which was based on an extra credit grading policy (Moscovici et al. 2022), is in parallel with our implementation of bonus points for grading policy which appears to be critical for the design of service-learning modules that participation in service learning should be on a voluntary basis and should be rewarded as an extra work.

Wikipedia editing assignment as a service learning is an innovative approach to foster student development of twenty-first-century skills such as information literacy, digital literacy, communication, community service, and social responsibility. However, the design and implementation of such an assignment require personalized approaches tailored for specific circumstances. In this context, special instruction might be required to foster student perception on social service and responsibility in digital community. The design of assessment components should be approached

with thoughtful consideration. Offering students the choice to engage in voluntary assignments or elective courses to earn extra grade points or credits seems to align more effectively with the desired learning outcomes. The course subject, the interest of students in the course subject, workload in the curriculum is among important factors determining the degree of student participation.

A small but growing number of HEIs train students to improve Wikipedia's content as a formal part of their pedagogy. Much less of these practices are investigated and presented in peer reviewed journals. Our innovative study, by developing and implementing a multilingual Wikipedia editing module in the HEI in Siberia and analyzing it as a pedagogical tool for service learning, contributes to filling these gaps. To our knowledge, the present study is the first study with these features for service learning and life science and technology education in HEIs in Russia and in Eurasia. Socially responsible higher education is a key theme for the realization of the "third mission" of HEIs, requiring a wide range of activities by which universities contribute to society impactfully (Stolze and Sailer 2022; Coelho and Menezes 2021). Thus, examining Wikipedia editing as a service-learning activity was a core motivation in our study which clarifies the need and the opportunity for student development as responsible citizens in the twenty-first century digital society.

Even though our study was intentionally oriented on how students perceive and understand Wikipedia editing assignments as ASL and how they reflect on participation in ASL activity, and because of that, qualitative analysis was used, we are aware of the potential limitations. Firstly, their biases and peer influences might affect students' answers during focus group interactions. Secondly, students could give socially desirable responses (Paulhus & Reid 1991) because focus groups could not provide complete anonymity. To minimize this risk, we divided the study into isolated tasks, with the first task involving the design and implementation of the assignment. This task was conducted solely by the course instructor (the first author), who did not participate in the focus groups. The second task, moderation of focus group discussion sessions, was carried out exclusively by the second author. Nonetheless, there remains a possibility that some students may consider taking a course from the authors in the future, which could influence the results obtained from the focus groups. Thirdly, the presence of potential limitations in this context is contingent on the transcription coding methods applied, especially if they involve exclusive coding by a single individual. Additionally, further analysis is needed to assess the accuracy, readability, and accessibility of the student editions to the public. Evaluating how the incorporation of Wikipedia editing into classroom instruction aligns with these objectives is also essential. Finally, it is important to consider that the availability of an extra point grade for Wikipedia editing may have impacted the decisions made by students regarding their participation in the assignment. For instance, if a student did not require the extra grade or credit, they might have opted not to engage in the task. Nevertheless, this study's results have their research strength and justification and serve as an excellent starting point for further mixed-method approach investigation in which more participants might be included and more parameters might be studied.

Our study presents the key benefits of an innovative ASL activity from the student's perspective and provides insights into its optimal design and implementation within the curriculum of HEIs. By coupling education with community service in an innovative way, our approach introduces opportunity for HEIs to contribute to their mission as HEIs often aim to instill a sense of social responsibility in their students besides quality education. Especially, our implementation in science and technology education can contribute effectively with the goals addressing the issues of life sciences, biotechnology, and society. It inherently contributes to the broader field of public health, life sciences, and community. By enhancing science and technology education through innovative approaches of ASL like Wikipedia-based service learning, our research contributes to opportunities for better-informed communities. Furthermore, it recognizes the importance of language diversity, especially in the context of Wikipedia, where relatively less represented languages find a platform for broader engagement and knowledge sharing. Thus, HEIs should consider implementing Wikipedia-based ASL activities, especially in science and technology education, to foster social responsibility, address real-world issues, promote language diversity, and enhance community engagement, aligning with their educational mission.

In a time when the merging of life sciences, genetics, and technology is increasingly essential for enhancing public health and dealing with ethical, legal, and social concerns, our educational initiative plays a pivotal role in advancing these fields. Furthermore, by illustrating its practical use within a specific geographic context, like Tyumen in Western Siberia, this research has the potential to illuminate the practices and challenges within communities characterized by distinct socio-cultural dynamics. Therefore, this study has the capacity to make a significant contribution to the mission of higher education institutions and the broader community by bridging the divide between education and the real-world applications of life sciences, public health, and genetics across diverse populations. Future studies should include longitudinal analysis to track the long-term effects of using Wikipedia as an academic service-learning tool. Our research did not provide information regarding the precision, comprehensibility, or accessibility of student edits to the general public. Consequently, additional research is necessary to determine whether the integration of Wikipedia

editing into classroom instruction aligns with these objectives. Also, a comparative analysis to address the effectiveness of using Wikipedia as an academic service-learning tool in Siberia with other regions or educational contexts will be important to analyze the contextual factors that may influence the outcome. Assessment, course subject, learning outcomes, and student engagement should be explored in different contextual settings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12687-023-00692-6.

Acknowledgements The authors would like to thank all students who participated voluntarily in the focus groups at the School of Advanced Studies in Russia. The authors would like to express their gratitude to the anonymous peer reviewers for their valuable time, expertise, and critical feedback during the review process. Their insightful comments and constructive suggestions greatly contributed to the improvement of this manuscript. We appreciate their dedication to maintaining the quality and integrity of academic research.

Author contribution A.A. conceived the idea and designed and implemented the Wikipedia-based service-learning activity in her classes at the School of Advanced Studies in Russia. M.T. designed the focus group study, conducted the focus group interviews, collected the data and performed the initial data transcription at the School of Advanced Studies. Both A.A. and M.T. analyzed the data. M.T. produced Fig. 1. A.A. produced Fig. 2 and Tables and prepared the majority of the revisions. The first draft of the manuscript was written by A.A., and all authors commented on previous versions of the manuscript. All authors revised and approved the manuscript.

Funding The empirical part of the study is partially funded by the School of Advanced Studies, University of Tyumen, Russia.

Data availability Raw data relevant to the profile of non-participants and participants are not publicly available to preserve individuals' privacy under the European General Data Protection Regulation.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval and consent to participate The researchers got institutional ethical permission, and students were introduced to informed consent for research participation. In the analysis phase, students (S) got their codes without naming their names or initials to ensure anonymity. The same codes were used in the citations of the research participants' answers with the letter P for participants and NP for non-participants.

Conflict of interest A.A. is a certified trainer for the "Training of Trainers program" led by the education team at the Wikimedia Foundation. A.A. was not sponsored by the Wikimedia Foundation for the conduction of this research. M.T. declares that he has no conflict of interest.

References

Adams I, Christopher J, Williams KP, Sheppard VB (2015) What Black women know and want to know about counseling and testing for BRCA1/2. J Canc Educ 30(2):344–352. https://doi.org/10.1007/s13187-014-0740-9

Allahwala UK, Nadkarni A, Sebaratnam DF (2013) Wikipedia use amongst medical students - new insights into the digital revolution. Med Teach 35(4):337. https://doi.org/10.3109/0142159X.2012.737064

Apollonio DE, Broyde K, Azzam A, De Guia M, Heilman J, Brock T (2018) Pharmacy students can improve access to quality medicines information by editing Wikipedia articles. BMC Med Educ 18(1):265. https://doi.org/10.1186/s12909-018-1375-z

Azzam A, Bresler D, Leon A et al (2017) Why medical schools should embrace Wikipedia: final-year medical student contributions to Wikipedia articles for academic credit at one school. Acad Med 92(2):194–200. https://doi.org/10.1097/ACM.0000000000001381

Basch CH, Fera J, Quinones N (2021a) A content analysis of direct-to-consumer DNA testing on TikTok. J Community Genet 12(3):489–492. https://doi.org/10.1007/s12687-021-00526-3

Basch CH, Hillyer GC, Wahrman MZ, Garcia P, Basch CE (2021b) DNA testing information on YouTube: inadequate advice can mislead and harm the public. J Genet Couns 30(3):785–792. https://doi.org/10.1002/jgc4.1375

Bateman A, Kelso J, Mietchen D et al (2013) ISCB computational biology Wikipedia competition. PLoS Comput Biol 9(9):e1003242. https://doi.org/10.1371/journal.pcbi.1003242

Bazzett TJ, Zahid Z, Brady MA (2018) Engaging, entertaining, and educating under-served and at-risk youth with STEM-based activities. J Undergrad Neurosci Educ 17(1):A89–A96

Begley GS (2013) Making connections: service-learning in introductory cell and molecular biology. J Microbiol Biol Educ 14(2):213–220. https://doi.org/10.1128/jmbe.v14i2.596

Bradu P, Biswas, A, Nair, C, Sreevalsakumar S, Patil M, Kannampuzha, Mukherjee AG, Wanjari UR, Renu K, Vellingiri B, Gopalakrishnan AV (2022) Recent advances in green technology and Industrial Revolution 4.0 for a sustainable future. Environ Sci Pollut Res. https://doi.org/10.1007/s11356-022-20024-4

Brand A, Evangelatos N, Satyamoorthy K (2016) Public Health Genomics: the essential part for good governance in public health. Int J Public Health 61:401–403. https://doi.org/10.1007/s00038-016-0828-6

Bringle RG, Hatcher JA (1996) Implementing service learning in higher education. J Higher Educ 67(2):221–239. https://doi.org/10.2307/2943981

Bringle RG, Hatcher JA (2000) Institutionalization of service learning in higher education. J Higher Educ 71(3):273–290

Buchholz K (2022) Which countries spend the most time on social media? https://www.weforum.org/agenda/2022/04/social-media-internet-connectivity/. Accessed 05.03.2023

Burdo JR (2012) Wikipedia neuroscience stub editing in an introductory undergraduate neuroscience course. J Undergrad Neurosci Educ 11(1):A1–A5

Buzsáki G, Draguhn A (2004) Neuronal oscillations in cortical networks. Science (New York, N.Y.) 304(5679):1926–1929. https://doi.org/10.1126/science.1099745

Cashman SB, Seifer SD (2008) Service-learning: an integral part of undergraduate public health. Am J Prev Med 35(3):273–278. https://doi.org/10.1016/j.amepre.2008.06.012

Ceballos DM, Herrick RF, Carreón T et al (2021) Expanding reach of occupational health knowledge: contributing subject-matter expertise to Wikipedia as a class assignment. Inquiry : A J Med Care Org, Provision Financing 58:469580211035735. https://doi.org/10.1177/00469580211035735

Chan BS, Churchill D, Chiu TK (2017) Digital literacy learning in higher education through digital storytelling approach. J Int Educ Res (JIER) 13(1):1–16. https://doi.org/10.19030/jier.v13i1.9907

Chiang CD, Lewis CL, Wright MD et al (2012) Learning chronobiology by improving Wikipedia. J Biol Rhythms 27(4):333–336. https://doi.org/10.1177/0748730412449578

Chiva-Bartoll O, Baena-Extremera A, Hortiguela-Alcalá D, Ruiz-Montero PJ (2020) Contributions of service-learning on PETE students' effective personality: a mixed methods research. Int J Environ Res Public Health 17(23):8756. https://doi.org/10.3390/ijerph17238756

Chrisman-Khawam LM, Manzi JA (2020) Empathy in medicine cultivating an empathetic professional identity in osteopathic medical students through service learning: a qualitative analysis of reflective essays. J Am Osteopath Assoc 120(4):263–272. https://doi.org/10.7556/jaoa.2020.043

Coelho M, Menezes I (2021) University social responsibility, service learning, and students' personal, professional, and civic education. Front Psychol 12:617300. https://doi.org/10.3389/fpsyg.2021.617300

Cohen L, Manion L, Morrison K (2000) Research methods in education (5th ed). Routledge, London. https://doi.org/10.4324/9780203224342

Cohen L, Manion L, Morrison K (2007a) Metode istraživanja u obrazovanju. Naklada Slap, Jastrebarsko

Cohen L, Manion L, Morrison K (2007) Metode istraživanja u obrazovanju. Naklada Slap, Jastrebarsko

Creswell JW (2014) Research design: qualitative, quantitative, and mixed methods approaches, 4th edn. California, SAGE Publications, Thousand Oaks

Crosswaite M, Asbury K (2016) Mr Cummings clearly does not understand the science of genetics and should maybe go back to school on the subject': an exploratory content analysis of the online comments beneath a controversial news story. Life Sci Soc Policy 12(1):11. https://doi.org/10.1186/s40504-016-0044-4

D'Alessio M, Rushing G, Gray TL (2021) Monitoring water quality through citizen science while teaching STEM undergraduate courses during a global pandemic. Sci Total Environ 779:146547. https://doi.org/10.1016/j.scitotenv.2021.146547

Davis LL, Sigalov SE, Maljković F, Peschanski JA (2023) The Wikipedia education program as open educational practice: global stories. In: Olivier J, Rambow A (eds) Open educational resources in higher education. Future Education and Learning Spaces Springer, Singapore. https://doi.org/10.1007/978-981-19-8590-4_12

Gasparis PT, Kerridge WD, Gunderman RB (2017) Service learning in radiology education. Acad Radiol 24(4):514–515. https://doi.org/10.1016/j.acra.2017.01.006

Gasteiger N, Vercell A, Davies A, Dowding D, Khan N, Davies A (2022) Patient-facing genetic and genomic mobile apps in the UK: a systematic review of content, functionality, and quality. J Community Genet 13(2):171–182. https://doi.org/10.1007/s12687-022-00579-y

Groh CJ, Stallwood LG, Daniels JJ (2011) Service-learning in nursing education: its impact on leadership and social justice. Nurs Educ Perspect 32(6):400–405. https://doi.org/10.5480/1536-5026-32.6.400

Grønkjær M, Curtis T, de Crespigny C, Delmar C (2011) Analysing group interaction in focus group research: impact on content and the role of the moderator. Qual Stud 2(1):16–30. https://doi.org/10.7146/qs.v2i1.4273

Grunig LA (2008) Using qualitative research to become the "thinking heart" of organizations. In: van Ruler B, Tkalac Verčič A, Verčič D (eds) Public relations metrics: research and evaluation. Routledge, New York, pp 120–136

Hansen AK, Connors P, Donnelly-Hermosillo D (2021) Biology beyond the classroom: experiential learning through authentic research, design, and community engagement. Integr Comp Biol 61(3):926–933. https://doi.org/10.1093/icb/icab155

Hebscher M, Wing E, Ryan J, Gilboa A (2019) Rapid cortical plasticity supports long-term memory formation. Trends Cogn Sci 23(12):989–1002. https://doi.org/10.1016/j.tics.2019.09.009

Herlihy NS, Brown C (2015) Innovations in service learning: a novel program for community service at NYU School of Medicine. Med Educ Online 20:28379. https://doi.org/10.3402/meo.v20.28379

Horning ML, Ostrow L, Beierwaltes P et al (2020) Service learning within community-engaged research: facilitating nursing student learning outcomes. J Prof Nursing. https://doi.org/10.1016/j.profnurs.2020.04.005

Jemielniak D (2019) Wikipedia: Why is the common knowledge resource still neglected by academics? Gigasscience 8(12):giz139. https://doi.org/10.1093/gigascience/giz139

Kahili-Heede MK, Patil U, Hillgren KJ et al (2022) Library instruction and Wikipedia: investigating students' perceived information literacy, lifelong learning, and social responsibility through Wikipedia editing. J Med Libr Assoc 110(2):174–184. https://doi.org/10.5195/jmla.2022.1291

Khan N, Kerr G, Kingston H (2016) Community engagement and education: addressing the needs of South Asian families with genetic disorders. J Community Genet 7:317–323. https://doi.org/10.1007/s12687-016-0278-0

Kilpatrick AM (2016) The 5th ISCB Wikipedia competition: coming to a classroom near you? PLoS Comput Biol 12(12):e1005235. https://doi.org/10.1371/journal.pcbi.1005235

Klein S (2018) Using Wikipedia in Israel Studies courses. Isr Stud Rev 33(1):102–109. https://www.jstor.org/stable/48563780. Accessed 15 Jan 2022

Kolb DA (1984) Experiential learning: experience as the source of learning and development. Prentice-Hall, New Jersey

Kolb AY, Kolb DA (2005) Learning styles and learning spaces: enhancing experiential learning in higher education. Acad Manag Learn Educ 4(2):193–212. http://www.jstor.org/stable/40214287

Kolb DA, Boyatzis R, Mainemelis C (2001) Experiential learning theory: previous research and new directions. In: Sternberg R, Zhang L (eds.) Perspectives on thinking, learning, and cognitive styles. Lawrence Erlbaum, New Jersey, pp 227–247

Kraft RW (1996) Service learning, an introduction to its theory, practice and effects. Educ Urban Soc 28:131

Lemke AA, Esplin ED, Goldenberg AJ, Gonzaga-Jauregui C, Hanchard NA, Harris-Wai J, Ideozu JE, Isasi R, Landstrom AP, Prince AER, Turbitt E, Sabatello M, SchrierVergano SA, Taylor MRG, Yu JH, Brothers KB, Garrison NA (2022) Addressing underrepresentation in genomics research through community engagement. Am J Hum Genet 109(9):1563–1571. https://doi.org/10.1016/j.ajhg.2022.08.005

Linares M, López-Ejeda N, Álvarez P, Culebras E et al (2021) Service-learning, movies, and infectious diseases: implementation of an active educational program in microbiology as a tool for engagement in social justice. Front Microbiol 12:589401. https://doi.org/10.3389/fmicb.2021.589401

Lipworth W (2019) Real-world data to generate evidence about healthcare interventions. Asian Bioethics Rev 11(3):289. https://doi.org/10.1007/s41649-019-00095-1

Maggio LA, Willinsky JM, Costello JA et al (2020) Integrating Wikipedia editing into health professions education: a curricular inventory and review of the literature. Perspect Med Educ 9(6):333–342. https://doi.org/10.1007/s40037-020-00620-1

Merriam SB (1998) Qualitative research and case study applications in education. Jossey-Bass Publishers, San Francisco

Moscovici K, Arie GB, Shelef I, Kalet A (2022) Creating Wikipedia articles on health and technology topics can empower the writers and benefit the community. BMC Med Educ 22(1):373. https://doi.org/10.1186/s12909-022-03389-5

Ngai SS (2006) Service-learning, personal development, and social commitment: a case study of university students in Hong Kong. Adolescence 41(161):165–176
Ottenritter NW (2004) Service learning, social justice, and campus health. J Am College Health : J of ACH 52(4):189–191. https://doi.org/10.3200/JACH.52.4.189-192
Pallen MJ (2016) Microbial bioinformatics 2020. Microb Biotechnol 9(5):681–686. https://doi.org/10.1111/1751-7915.12389
Parker-Gwin R, Mabry JB (1998) Service learning as pedagogy and civic education: comparing outcomes for three models. Teach Sociol 26(4):276–291. https://doi.org/10.2307/1318768
Parsi K, List J (2008) Preparing medical students for the world: service learning and global health justice. Medscape J Med 10(11):268
Paulhus DL, Reid DB (1991) Enhancement and denial in socially desirable responding. J Pers Soc Psychol 60(2):307–317. https://doi.org/10.1037/0022-3514.60.2.307
Pérez-Ordás R, Nuviala A, Grao-Cruces A, Fernández-Martínez A (2021) Implementing service-learning programs in physical education; teacher education as teaching and learning models for all the agents involved: a systematic review. Int J Environ Res Public Health 18(2):669. https://doi.org/10.3390/ijerph18020669
Pilling R, Mollaney J, Chandauka R, Barai I, Parekh R (2021) "Bursting the bubble": service learning in schools. Clin Teach 18(2):163–167. https://doi.org/10.1111/tct.13279
Rekhter N, Hossler D (2020) Russian students' use of social network sites for selecting universities abroad: case study at the Russian State University for the Humanities. J Int Students 10(3):724–740. https://doi.org/10.32674/jis.v10i3.778
Rideout V (2015) The common sense census: media use by tweens and teens in America, a common sense media research study. United States 2021(06):21. https://doi.org/10.3886/ICPSR38018.v1
Romo JA, Rokop ME (2022) A novel undergraduate seminar course celebrating scientific contributions by scientists from historically marginalized communities. J Microbiol Biol Educ 23(3):e00123-e222. https://doi.org/10.1128/jmbe.00123-22
Rubin JE (2022) Writing for Wikipedia: an exercise in microbiology, writing, research, communication, and public service. J Vet Med Educ 49(6):705–708. https://doi.org/10.3138/jvme-2021-0099
Saha S, Guha A (2021) Impact of social media use of university students, pp 36–43. https://doi.org/10.5923/j.statistics.20190901.05
Schmidtke J, Cornel MC (2020) A new decade of community genetics: old and new challenges. J Community Genet 11:1–3. https://doi.org/10.1007/s12687-019-00448-1
Sigalov SE, Nachmias R (2017) Wikipedia as a platform for impactful learning: a new course model in higher education. Educ Inf Technol 22:2959–2979. https://doi.org/10.1007/s10639-016-9564-z
Similarweb (2023) Top websites ranking. Similarweb Ltd. https://www.similarweb.com/top-websites/. Accessed 07.03.2023
Smith DA (2020) Situating Wikipedia as a health information resource in various contexts: a scoping review. PLoS ONE 15(2):e0228786. https://doi.org/10.1371/journal.pone.0228786
Stakić Đ (2009) Wiki technology—origin, development and importance. Infotheca 10(1). http://infoteka.bg.ac.rs/index.php/en/archives/2009/infoteka-10-1-2-2009-69-78. Accessed 20 Oct 2023
Stakić Đ, Tasic M, Stanković M, Bogdanović M (2021) Students' attitudes towards the use of Wikipedia: a teaching tool and a way to modernize teaching. Área Abierta 21(2):309–325. https://doi.org/10.5209/arab.72760
Stolze A, Sailer K (2022) Advancing HEIs' third-mission through dynamic capabilities: the role of leadership and agreement on vision and goals. J Technol Transf 47(2):580–604. https://doi.org/10.1007/s10961-021-09850-9
Tanna S, Fyfe M, Kumar S (2020) Learning through service: a qualitative study of a community-based placement in general practice. Educ Primary Care 31(5):305–310. https://doi.org/10.1080/14739879.2020.1759459
Toussaint P, Renner M, Lins S, Thiebes S, Sunyaev A (2022) Direct-to-consumer genetic testing on social media: topic modeling and sentiment analysis of YouTube users' comments. JMIR Infodemiology 2(2):e38749. https://doi.org/10.2196/38749
Webb G (2017) A review of microbiology service learning. FEMS Microbiol Lett 364(4). https://doi.org/10.1093/femsle/fnx032
Weigert KM (2002) Academic service learning: its meaning and relevance. New Dir Teach Learn 1998:3–10. https://doi.org/10.1002/tl.7301
Yorio PL, Ye F (2012) A meta-analysis on the effects of service-learning on the social, personal, and cognitive outcomes of learning. Acad Manag Learn Educ 11(1):9–27. http://www.jstor.org/stable/23100454