

The impact of undergraduate students' perceived social media empowerment in their engagement in sustainability practices: a predictive study

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Abstract. Undeniably, the contemporary world is amid a digital revolution, where digital technology has emerged as a powerful, transformative tool that fosters engagement in sustainability initiatives. In light of that contention, this predictive study explored social media empowerment through participation and engagement, access to resources and support, and self-expression and control, analysing their influence on students' engagement in sustainability practices. Based on the quantitative approach and cross-sectional design, pertinent data were collected from 510 undergraduate students using a closed-ended self-developed questionnaire. Subsequently, the collected numerical data were subjected to quantitative analysis, employing descriptive and inferential analysis. The three hypotheses developed were tested using structural equation modelling (SEM). The study findings revealed that all three hypotheses were accepted, establishing a positive and statistically significant relationship between social media empowerment and students' perceived engagement in sustainability practices. While all exogenous constructs influenced endogenous constructs, their magnitude of impact varied. The construct of participation and engagement ($\beta=0.311$, $p<.0001$, $R^2=0.469$) depicted the highest predictive power, followed by access to resources and support ($\beta=0.106$, $p=0.041$, $R^2=0.210$). The construct of self-expression and control ($\beta=0.319$, $p<.0001$, $R^2=0.102$) established the lowest predictive power. Therefore, the observed variation underscores the differential role of each construct in enhancing students' engagement in sustainability practices. The findings signify the importance of comprehensive approaches in promoting sustainable practices among undergraduate students through meaningful engagement on social media.

Keywords: social media, sustainability, social media empowerment, sustainability practices, undergraduate students

1. Introduction

In the contemporary era of digital dynamism, understanding the influence of digital tools on users' Engagement in Sustainability Practices (ESP) is critical for advancing sustainable initiatives. Among these tools, social media has emerged as a transformative and empowering platform for promoting users' ESP [27, 45, 49]. Social media provides youth, including undergraduate students, access to sustainable information, interactive spaces for dialogue and avenues for expressing their identities as agents of change [9, 11, 49]. In that regard, through social media, users are exposed to sustainability challenges regarding sustainability practices and solutions, shaping their awareness, subsequently influencing their sustainability behaviour [12, 40, 54].

However, a persistent question remains: Does exposure to sustainability issues via social media steer youth engagement into meaningful sustainability practices, or is it just superficial activism? [33, 68]. Notably, this study sought to bridge this empirical gap by exploring the impact of social media-led empowerment on ESP from the

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undergraduate students' perspectives. Specifically, it examined how the parameters of participation, self-expression and access to information facilitated by social media shape students' ESP. Besides, the study investigated how these parameters foster behavioural change, collaboration, and sustainability-related collective action.

1.1. Policy context

The approach of technology-driven innovation in addressing escalating sustainability challenges is steadily emphasised globally. Most notably, the United Nations 2030 Agenda for Sustainable Development [79], underscores the potential of digital solutions in achieving several Sustainable Development Goals (SDGs) [42]. Besides, SDG 4 on quality education emphasises the importance of digital learning in enhancing sustainability competencies, whereas SDG 13 on climate action highlights the use of digital platforms in promoting climate action [79]. Similarly, the UNESCO Global Framework for Education for Sustainable Development (ESD) for 2030, underscores digital tools as paramount for youth's engagement and participation in sustainability initiatives [71].

On the same note, the African Union's Digital Transformation Strategy for Africa (2020–2030) highlights the role of digital technologies in advancing sustainable development [2]. This aligns with the National ICT Policy in Tanzania, which emphasises using digital tools, including social media, to support local and international development objectives [75]. Likewise, the Education and Training Policy of 2014, 2023 Edition [81], promotes digital tools in enhancing the quality of education, including ESD. In addition, the National Digital Education Strategy 2024–2030 [74] and the Tanzania Digital Economy Strategic Framework 2024–2034, highlight commitments to leveraging digital innovations for social and economic sustainability in the country [76].

Despite the policy directives, implementing sustainability practices related to the digital transformation has remained uneven due to various factors such as socio-economic disparities, limited infrastructure and policy-practice gaps [68]. Nevertheless, the inclusion of bottom-up strategies and the increased educational outreach are vital for maximising the impact of these policy initiatives [23, 64].

1.2. Social media as an empowerment digital tool

Digital technologies are steadily recognised for their potential in offering innovative solutions for sustainability challenges [12, 27, 49]. In particular, social media platforms are seen as uniquely positioned tools to empower youth in fostering sustainability-oriented behaviours [27]. In this context, they enable youth to participate, access data and express themselves in a way that supports their engagement with sustainability practices [12, 45, 54]. Similarly, Confetto et al. [16] noted that frequent exposure to sustainability content on social media correlates with more environmentally conscious behaviours. Correspondingly, Li et al. [43] asserted that social media use positively influences sustainable lifestyle attitudes. Nevertheless, the extent to which these attitudes are translated into tangible, offline sustainability practices amongst undergraduate students is still underexplored [50, 83]. In that regard, this study explored how the dimensions of participation, self-expression and information access via social media could empower university students to engage in ESP meaningfully.

1.3. Social media and engagement with sustainability practices

Youth, including undergraduate students who are presumably technologically savvy, can embrace social media as empowerment tools for information access, platforms for dialogue and opportunities for advocacy of sustainability issues [9, 11]. In this manner, quite a good number of scholars emphasise the innovative use of digital technology

tools, including social media, as an empowerment for sustainability practices [9, 11, 27]. In furtherance of this argument, Liao [45] and Li and Noor [44] reiterated that social media can foster sustainability competences and socially driven action towards a more prosperous and sustainable future. Thus, sustainability practices can be reflected through individuals' concerns and involvement in sustainability actions, including: advocating for sustainability, using sustainable products, recycling and conserving energy [66].

However, the potentiality and actuality of social media in enhancing sustainability practices among youth are contingent; in the view of the fact that some youth might translate online engagement into substantive sustainability practices, while other youth's participation, including undergraduate students, remains superficial online [68]. Besides, the effective actualisation of digital technologies in support of sustainability practices continues to be hindered by persistent barriers such as the digital divide, limited digital literacy and inadequate enabling conditions [57]. Thus, Morote and Moreno [53] cautioned the challenges related to interpreting and critically evaluating information on social media, which might contain errors that must be identified. Hitherto, social media as an empowerment tool was seen as a transformative cultural force, shaping how sustainability information is created, shared and practised within a particular community [27, 60].

1.4. Optimism for leveraging digital technologies for sustainable practices

Despite the challenges hindering digital-led sustainability practices, there is a growing expectation for progress. This optimism is driven by a number of factors, such as the growth of a youth-digital savvy population and the adaptation of mobile technologies for learning [33, 78]. According to the United Nations Department of Economic and Social Affairs (UNDESA), the global youth population is expected to reach 1.29 billion by 2030 [80]. In particular, youth who comprise about two-thirds of the population in developing countries have the imperative roles to play towards their sustainable future [17]. In that context, other scholars advocate for the youth to demonstrate pro-environmental behaviour and promote sustainability practices and values within their society [7, 10, 28].

Along similar lines, youths' engagement with sustainability practices is vital not only for the present but also for overcoming the long-term consequences of sustainability challenges. As argued by Orsini [56], this perspective can guide youths' participation to alter sustainability challenges and aligns with the present people-centred development approaches. However, there is a concern that youth, including undergraduate students, do not give the sustainability practices due consideration in their educational practices [62]. This has been an issue of concern in the sense that youth's engagement in sustainability practices is crucial for their future prosperity and society as a whole.

On the other hand, the exponential growth of mobile technologies is imperative for information dissemination, particularly among youth, including undergraduate students. According to de Feydeau, Menski and Perry [19], it was predicted that, in Africa, by 2025, mobile technology penetration would reach 50% (more than 600 million connections, 65% via smartphone). In that regard, digital platforms like X, WhatsApp, and Facebook have increasingly become venues for youth mobilisation to advocate pressing issues. These digital platforms have provided a promising venue for individuals, especially youth, to engage with sustainability practices, leading to positive social and environmental impacts [78]. However, it is worth noting that digitisation can cause unintended consequences such as increased energy consumption and electronic waste, risking a further acceleration of sustainability problems [9, 11]. Given the fact that not all digital technologies contribute to the prosperity of human beings

[11], there are compelling dilemmas related to their novel use in order to achieve the anticipated sustainability goals within society [9, 49].

Notably, there are abundant empirical studies on the communicative potential use of social media among undergraduate students [12, 48, 60, 61] and on the impact of digital technologies in sustainability [27, 49]. Researchers have also explored the potential of social media for enhancing sustainability consciousness [45, 54, 78]. However, there is a gap in examining the potential of social media-led empowerment in fostering students' ESP from the perspective of undergraduate students. Based on that, it remains necessary to examine whether undergraduate students' empowerment on sustainability practices through social media translates into meaningful ESP or merely reflects superficial activism in that regard [33].

In particular, the potential of social media for promoting sustainable behaviours among undergraduate students has not been fully explored in the Tanzanian context. The study on social media empowerment is paramount because undergraduate students, youth inclusively, can strategically leverage digital tools and engage in sustainability practices. Therefore, concerning their perspectives, this study explored the impact of social media-led empowerment on ESP amongst undergraduate students in Tanzania. Specifically, the study intended to establish a link between undergraduate students' perceptions of social media empowerment and their ESP within the broader goals of the digital transformation to leverage digital technology for their sustainable future and the prosperity of society as a whole.

2. Literature review and formulation of research hypotheses

2.1. Theoretical foundations

This study was grounded in the empowerment theory proposed by Rachmad [63], which highlights factors influencing the development of a sense of control over one's life and the values of individuals or groups. Moreover, the theory highlights autonomy and control, active participation and responsibility, and access to resources and support, as the main elements of empowerment [63]. According to this theory, these social forces shape and modify individual or group empowerment. Therefore, the theory describes the underlying empowering degree of autonomy, active participation and resource access.

The theory is relevant to this study in that it helps explicate the relationship between social media as an empowering tool for undergraduate students concerning ESP. Notably, the theory involves several key assumptions. Firstly, social media can create an environment that supports active participation and empowers undergraduate students to advocate for change. This is in line with Liao [45], who emphasised that young people utilise social media to exchange and share meanings about contemporary issues, indicating its role in fostering active participation in sustainability practices. Secondly, social media can provide access to important resources to acquire knowledge about environmental issues and sustainability practices. In relation to the assumption, the study findings by Hodson et al. [33] document that social media is a viable platform where students can access and disseminate sustainability-related content, influencing their likelihood to participate and combat sustainability challenges.

Thirdly, through digital-supported open and transparent communication, social media can enable students to express their views and collaborate on sustainability initiatives, as Hodson et al. [33] highlights the potential of social media in hosting open dialogue for the sake of promoting students' engagement with sustainability issues. Therefore, the empowerment theory was used in this study since it enabled the researcher to explore how social media serves as a tool for empowering undergraduate students with sustainability practices through active engagement, resource

accessibility and autonomous communication.

2.2. Related literature and development of research hypotheses

2.2.1. Social media-enabled participation and engagement

Considering the potential of social media to empower youth's participation and engagement, it is advocated that youth, including undergraduate students immersed in digital culture [1], are key beneficiaries of social media platforms. This assertion is supported by the study by Attavar and Rani [5] who found that social media is a powerful tool to support people's engagements in various ways, such as content creation, sharing and online communication.

However, recent studies underscore that social media platforms are not neutral virtual spaces since their specific affordance features significantly influence how users engage with each platform [41, 77]. In addition, Koehler and Vilarinho-Pereira [41] demonstrated that the educational affordances of social media, such as collaboration, visibility and interaction, are closely tied to the degree to which these features are embedded in a platform's interface design. This has been evidenced by Theocharis et al. [77], who analysed civic participation across three countries and found that platform-specific affordances shape how users engage politically.

Despite these affordances, challenges linked to specific social media design, generally, social media are regarded as viable platforms for advocating collaborative, participatory and engagement in sustainability practices [9, 11, 27, 51]. In addition, Ansari and Khan [4] reiterates that online knowledge-sharing behaviour predicts students' engagement significantly. Whilst Loader, Vromen and Xenos [46] underscored the influence of the social networking environment on sustainability participation, especially in political and civil engagement. In that context, the first hypothesis reads as follows:

H1: Participation empowered by digital social media is significantly associated with students' engagement in sustainability practices.

2.2.2. Access to resources and support

Digital technologies, including social media, are excellent platforms for retrieving resources related to sustainable development, thereby increasing people's awareness and understanding of sustainability practices [10, 66]. This, in turn, may possibly lead to changes in their attitudes, values and behaviours towards sustainability practices. Similarly, Ansari and Khan [4] explored the applications and usefulness of social media in transferring and accessing sustainability resources among academicians and university students. The findings revealed that social media use significantly impacted interactivity with peers and knowledge-sharing behaviour. Similarly, Geraldo and Pinto [26] found that social media are ideal platforms for disseminating sustainability resources, information and raising awareness regarding various issues, including sustainability.

In addition, a study by Abbas et al. [1] explored the potential of social media platforms in giving out sustainable health information and support during the COVID-19 pandemic. The findings confirmed that social media platforms can be a powerful tool for informing and educating people about health issues and how they help reduce the mental health consequences of the COVID-19 pandemic. On the other hand, a study by Riehm et al. [65] found that students with a high level of information seeking through social media presented high levels of well-being and risk perception. Thus, the study findings could help acknowledge the access to resources and information seeking on social media and their impact on sustainability behavioural changes. In that regard, the second hypothesis reads as follows:

H2: Information access and support empowered by digital social media is significantly associated with students' engagement in sustainability practices.

2.2.3. Self-expression and control

Several studies have been conducted to document the potential of social media to empower youth and promote their identity and control in various social and economic sustainability [51]. On the same note, it is emphasised that social media can be a powerful tool for self-expression [46, 51]. Besides, the contention was supported by Hu et al. [35], who argued that social media increasingly transforms users' perspectives regarding self-identity and community engagement. Moreover, according to Chapman [14] coupled with the study by Sebre and Miltuze [69], the current youth's socio-cultural themes related to social media use include identity formation, civic engagement and sustainability issues. In addition, access to social media platforms through mobile technologies is a breakthrough, through which young people's voices can be heard in their communities and societies. In this context, the third hypothesis reads as follows:

H3: Self-expression empowered by digital social media is significantly associated with students' engagement in sustainability practices.

2.2.4. Sustainability practices

As a philosophical construct, sustainability practices are multidimensional and complex [36, 52]. In the context of the present study, sustainability practices refer to the perceived action or behaviour intending to achieve a specific desired development target, such as energy conservation and reducing waste [36]. It is about observable actions and behaviours that contribute directly to the sustainability values. As already presented, it is anticipated that undergraduate students can secure the advantages of social media as a transformative and empowering tool, which leads to engagement with sustainability practices. Remarkably, various literatures highlight the variables such as behavioural change [12], community outreach [54] and collaboration [45] as fundamental variables linked to sustainability practices.

In that context, behavioural change involves the process of modifying observable actions to achieve sustainability benefits [8]. This perspective is supported by scholarly literature emphasising the necessity of transforming human behaviours to promote sustainable development [40]. Thus, social media can serve as a stimulus that raises awareness of sustainability issues and promotes sustainability practices. The assertion is supported by Carpenter et al. [12], who studied the perceived functions of social media held by university communities in the United States and found that social media platforms are perceived as helpful in encouraging action and disseminating information. In addition, it was found that there is a clear link between the use of social media and sustainability practices.

In sustainability practices, community outreach involves enriching and engaging others about sustainability and mobilising collective action for social prosperity [84]. Similarly, Napawan, Simpson and Snyder [54] explored the potential of social media as an alternative channel for engaging youth in climate resilience planning. Their study underscored the role of social media in enhancing community outreach and engagement among youth. According to Carpenter et al. [12], the values such as social responsibility and participating in community outreach are vital in fostering sustainability practices among university communities. In that regard, these studies underscore the usefulness of social media in fostering sustainability practice-related community outreach.

Furthermore, collaboration enhanced by social media is also regarded as a determinant variable for individuals engaging in sustainability practices. By leveraging social media communication, youth can connect with peers and collaborate on sustainability campaigns such as climate change. Likewise, Liao [45] investigated the impact of social media usage on pro-environmental behaviour. The findings signify that social media platforms facilitate collaboration and collective efforts toward environmental sustainability. The study also established a significant correlation between social media and environmental attitudes, as indicated by Li and Noor [44], that collaboration enhanced by social media can promote individuals' attitudes toward sustainability information. However, a study by Décamps et al. [20] found a gap between knowledge and attitudes, which might hinder their engagement in sustainability practices.

3. Research methodology

3.1. Research approach and design

This predictive study examines the relationship between social media empowerment and sustainability practices from undergraduate students' perspectives. The study adopted a quantitative approach [18], which was well-suited to identify, quantify and analyse the relationships between variables and was ideal for hypothesis testing [13, 21]. Consequently, in the framework of the present study, the formulated hypotheses regarding the influence of social media on ESP were investigated through a quantitative approach and strategies. Furthermore, the study employed a survey-based quantitative design [85] to systematically collect pertinent data. Thus, the survey-based quantitative design was deemed effective for gathering pertinent data from a large population, and the design is well-suited for identifying relationships between variables [85]. In light of this study, numerical data collected through a survey captured the extent to which social media empowerment influences undergraduate students with ESP.

3.2. National and institutional context

Tanzania, a country in East Africa, is committed to achieving the UN SDGs, particularly through policies integrating digital technologies in education. Key frameworks such as the Education and Training Policy [81], National ICT Policy [75], and the National Digital Education Strategy 2024–2030 [74] emphasise the development of sustainability competencies through digital tools, including social media. Despite these commitments, policy implementation faces challenges such as limited funding, weak monitoring and evaluation and gaps in digital access [74, 81]. As a result, digital literacy has remained low, considering that many students in the country at primary, secondary and tertiary levels lack adequate access to devices and internet connectivity.

The information from Kemp [38] reveals that Tanzania's internet penetration stood at 29.1% in early 2025 – surprisingly below the global average of 66.2%. Still, the progress is evident, with internet subscriptions rising by 16.1% from 41.4 million in September to 48 million by December 2024 [73]. Moreover, the university where this study was carried out took part in national initiatives such as the Education Sector Development Programme (ESDP) and the Higher Education for Economic Transformation (HEET) project. These programs, led by MoEST and Tanzania Commission for Universities (TCU), aim at enhancing access, quality and digital infrastructure in higher education, while promoting ICT integration and sustainability competencies [72].

3.3. Study respondents and sampling techniques

The study respondents were selected from a public university in Tanzania, the University of Dodoma, in one of the departments of the College of Education. The respondents were student teachers enrolled in two educational degree programs,

namely: Bachelor of Adult Education and Community Development, and Bachelor of Education in Arts – both of which explicitly integrate sustainability themes into their curricula. Courses such as “Lifelong Learning for Sustainable Development” and content from community development modules addressed key social sustainability issues, including gender equality, marginalisation and human rights. In addition, Geography courses, one of the teaching subjects, exposed students’ teachers to environmental education, covering topics such as climate change, conservation, waste management and resource stewardship. Notably, student teachers in Tanzania are uniquely positioned to engage with the sustainability aspect both theoretically and practically, reflecting a comprehensive institutional commitment to sustainability-oriented teacher education.

This study employed purposive and convenience sampling techniques to select the current study respondents. Purposive sampling was used to select second-year undergraduate students registered in the academic year 2023/2024 for the course entitled, “Lifelong Learning for Sustainable Development”. The Department of Educational Foundation and Continuing Education offers this core course in the second semester of each academic year. In that context, purposive sampling focused on individuals already engaged in sustainability concepts, subsequently making them suitable for examining the influence of social media on their ESP. In addition, during data collection, the respondents were conveniently approached through WhatsApp social media groups.

This study consisted of 510 respondents. Among these, 257 respondents, equivalent to 50.4% of the study respondents, were males, while 253 respondents, equivalent to 49.6%, were females. Moreover, most of the respondents, 376, equivalent to 73.7%, were between 21-25 years of age, followed by 26-30 years of age, who were 54 respondents, equivalent to 10.6%, and the ones who were 31 years of age and above were 74, equivalent to 14.5%. In addition, the respondents aged between 15 and 20 years were the least represented, with six respondents, equivalent to 1.2%. Besides, the student teachers were enrolled in two bachelor’s degrees: Bachelor of Adult Education and Community Development with 168 respondents, equivalent to 32.9% and Bachelor of Arts in Education with 342, equivalent to 67.1%. During data collection, the findings found that all respondents were social media users, whereas 233 respondents, equivalent to 45.7%, owned and managed one or two social media accounts, while 277 respondents, equivalent to 55.3%, were social media users owning and managing more than two accounts.

3.4. Analytical framework and data collection tool

A self-developed questionnaire was employed to measure the impact of the construct related to social media empowerment on ESP as perceived by undergraduate students. The selection of the study variables was guided by the empowerment theory [63, 88] which conceptualises empowerment as comprising social-psychological factors such as self-autonomy and control, active participation and responsibility and access to resources and support. These factors are also informed by cognitive, emotional and behavioural dimensions of psychological empowerment [88]. In the framework of the current study, social media empowerment was operationalised through three dimensions: self-expression and control, access to resources and support, and participation and engagement.

Regarding the questionnaire development, the initial stage involved literature reviews [36, 44, 52, 84] on the items in relation to the measurement of social media empowerment and ESP. The draft items were created to measure each construct in the subsequent stage. Thereafter, the created items list was sent for content and face validity to two experts from digital learning and sustainability practices. Besides, the

other items on the list were sent to one expert from the field of quantitative research. Finally, the inputs from the experts were incorporated into the final version of the study questionnaire.

The final version of the developed questionnaire consisted of three main sections. The first section consisted of 6 items, which were used to measure the respondents' demographic data, while the second section (Scale-A) consisted of 21 items, which were used to assess undergraduate students' perception of social media empowerment and ESP. Furthermore, Scale-A was divided into three subscales, namely: self-expression and control (6 items), access to information and support (7 items) and participation and engagement (8 items). Scale-A evaluated items from 1 (strongly disagree) to 5 (strongly agree). The third section (Scale-B) comprised 18 items to measure a construct related to undergraduate students' perception of ESP. In addition, Scale-B was divided into three subscales: behavioural change, community outreach/engagement and collaboration, each comprising six items. The scale-B measurement was in Likert Scale type with five points, which was rated as 1 (never) and 5 (always). On this basis, the final questionnaire consisted of 45 items with closed-ended questions and a five-point Likert scale. Table 1 provides an overview of the questionnaire items.

Table 1

A sample of questionnaire items in each measured dimension.

Dimension	Sample items
<i>Scale A: Social media empowerment</i>	
Self-expression and control	Social media connect me with like-minded individuals and sustainability-focused communities. It enhances my sense of belonging to sustainability initiatives.
Access to resources and support	I access diverse information on sustainability issues through social media. Social media keep me informed about sustainability trends and news.
Participation and engagement	It enables me to express my views on sustainability effectively. I actively share sustainability-related content online.
<i>Scale B: Engagement in sustainability practices</i>	
Behavioural change	I discover and enrol in sustainability courses or workshops via social media. I engage in social media campaigns promoting water conservation and adopt these habits.
Community outreach	I volunteer for local sustainability projects found on social media. I use social media to organise or join environmental activities like clean-ups and tree-planting.
Collaboration	I collaborate on sustainability projects through social media groups. I participate in sustainability discussions in online forums.

Patently, concerning table 1, internal consistency of the questionnaire was assessed using composite reliability (CR). Notably, all latent constructs, namely self-expression and control (CR=0.861), access to resources and support (CR=0.813) and participation and engagement (CR=0.838), were observed to have a favourable internal consistency. With CR, values greater than 0.7 are designated good reliability for each construct

[30]. On the other hand, in order to test convergent and discriminant validity, the average variance extracted (AVE) was used. As indicated in table 2, the AVE of the constructs ranged from 0.559 to 0.693. This value provided strong evidence with regard to convergent validity since the required AVE value was greater than 0.50 and lower than the CR value [32]. Furthermore, to ascertain discriminant validity among latent constructs, maximum shared squared variance (MSV) was performed; hence, the MSV for access to resources and support (0.206), participation and engagement (0.161) and self-expression and control (0.206). In that regard, MSV was less than AVE, providing evidence of discriminant validity as latent constructs were not overly correlated with each other [30].

Table 2

Indicators of reliability, convergent and discriminant validity.

Latent constructs	CR	AVE	MSV
Self-expression and control	0.861	0.559	0.206
Access to resources and support	0.813	0.684	0.206
Participation and engagement	0.838	0.693	0.161

3.5. Data collection procedures

Regarding data collection procedures, a self-developed closed-ended questionnaire was administered to second-year undergraduate students. The questionnaire was administered online through social media, a WhatsApp group in particular, in the 12th and 13th weeks of semester two, in the academic year 2023-2024. The WhatsApp group consisted of 878 students registered to pursue the “Lifelong Learning for Sustainable Development” course. The online questionnaire was considered a good method of data collection based on its advantages, including: time convenience, easy deployment, flexibility, automation and inexpensive modern means of data collection [6, 55]. According to Ball [6], an online questionnaire can be rapidly administered and completed by respondents, particularly when distributed via popular social media such as WhatsApp.

Despite the usefulness of the online data collection method, there are some downsides, including sampling, controlling the data collection environment, low response rate and the challenges related to confidentiality [3, 55]. These concerns have posed serious challenges to the validity and reliability of the online survey practices. Being aware of these challenges, the researcher took some measures to address them, which included: sharing a link to a specific social media group on WhatsApp accompanied by detailed explanations with regard to the purpose of the study, periodicity of follow-up messages and a tutorial on how to fill in the online questionnaire. Other measures were: anonymity as the questionnaire did not include the identifying information and insisted that each respondent should complete a survey only once [3, 6].

3.6. Analytical procedures

Data cleaning involved multiple imputation methods, dealing with a complete dataset of 510 responses. All analyses were performed by SPSS version 25 and AMOS version 25. Descriptive statistics were performed, resulting in metric measures of central tendency: the mean and the standard deviation. Structural Equational Modelling (SEM) was used to determine the statistical relationship between the constructs measured, social media empowerment and engagement in sustainability practices. The choice of SEM was informed by the purpose of the study, predicting the relationship among social media empowerment factors (latent variables) and assessing the variance explained in students’ engagement with sustainability practices. SEM is highly

regarded as a robust advanced statistical strategy as it catches measurement error, allows simultaneous estimation of multiple dependent relationships and can contend complex models with reflective constructs [30, 67].

4. Findings

4.1. Measurement model assessment

A measurement model was developed before generating structural models, which consisted of three factors as illustrated in figure 1. Most factor loadings are above 0.70, indicating a strong relationship [30]. Moreover, the path coefficients of 0.25, 0.28 and 0.36 established the strength of the relationships between latent constructs.

Figure 1 depicts that all three latent constructs better fit the data. In particular, a model shows that access to information positively influences participation and engagement (0.36), whereas self-expression and control hold moderate influences on the remaining two constructs. Therefore, the model suggests that if social media users have more access to sustainability content and opportunities for self-expression, they are more likely to feel empowered to engage in sustainability practices.

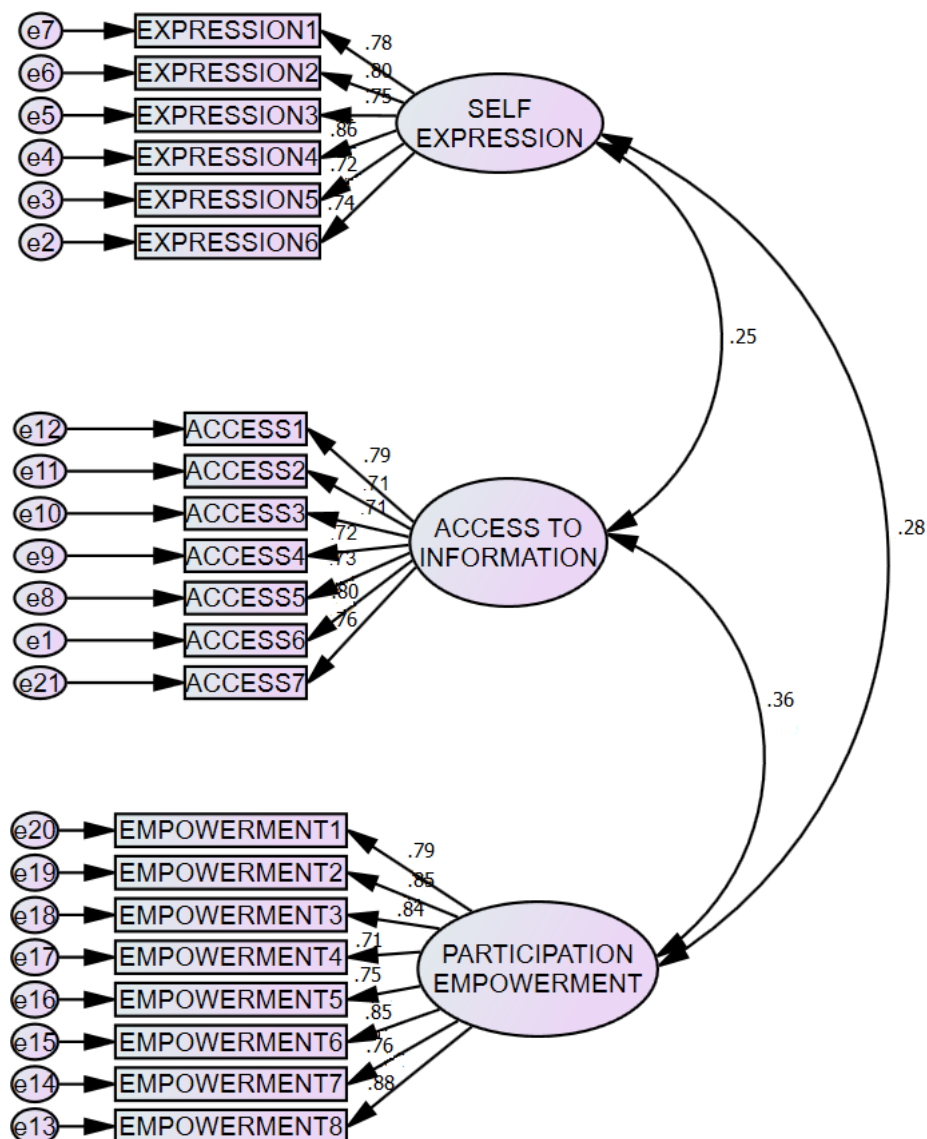


Figure 1: Structural equation model of latent constructs.

As further illustrated in table 3, the proposed model fit values are close to the cut-off points used to evaluate fitness. The excellent fit indices χ^2/df index of the model is 4.310. This value is less than 5, which is the recommended value indicating that the proposed model provides a better fit to the data than alternative models [29]. Moreover, the obtained values for the goodness of fit index (GFI) (1.005) and the comparative fit index (CFI) (1.000) both exceeded the recommended value of 0 [31]. The root mean square error of approximation (RMSEA) (0.019) was less than the recommended cut-off value 0.05. Table 3 summarises the CFA indices.

Table 3

Goodness-of-fit statistics for the structural equation model.

Fit statistic	Recommended	Obtained
$\chi^2/\text{degrees of freedom}$	<5	4.310
root mean square error of approximation	<0.05	0.019
p-value for test of close fit	>0.05	0.071
goodness of fit index	>0.90	1.005
adjusted goodness of fit index	>0.80	0.970
root mean residual	<0.05	0.000
Incremental fit indices		
normed fit index		0.380
comparative fit index	>0.90	1.000
Tucker-Lewis index	>0.95	0.990
incremental fit index	>0.95	1.000

4.2. Hypothesis testing

This section presents the findings based on the parameter estimates of the structural model based on three research hypotheses.

4.2.1. H1: Participation empowered by digital social media is significantly associated with students' engagement in sustainability practices

The results in table 4 strongly support the hypothesis that participation empowered by social media usage positively influences ESP ($\beta=0.311$, $p<.0001$).

Table 4

Parameter estimates for the effect of participation on ESP.

Exogenous	Endogenous	Estimate	Standard error	CR	p	R ²
Participation and engagement	→ ESP	0.311	0.074	5.5	<.0001	0.469

In addition, the study findings depict that the relationship is statistically significant and explains 46.9% of the variance in ESP levels ($R^2=0.469$). Furthermore, the CR=5.500 is well above 1.96, confirming statistical significance at the 95% confidence level. The effect of participation empowered by social media usage on students' ESP is further illustrated through a SEM (figure 2).

As indicated in figure 2, the factor loading for an exogenous construct ranges from 0.71 to 0.85, suggesting a strong relationship between these observed indicators and the underlying construct [29, 30]. The standardised path coefficient of 0.31 shows that the exogenous construct influences the endogenous construct. This confirms a positive and statistically significant impact, proposing that the higher participation empowered by social media usage correlates with increased ESP.

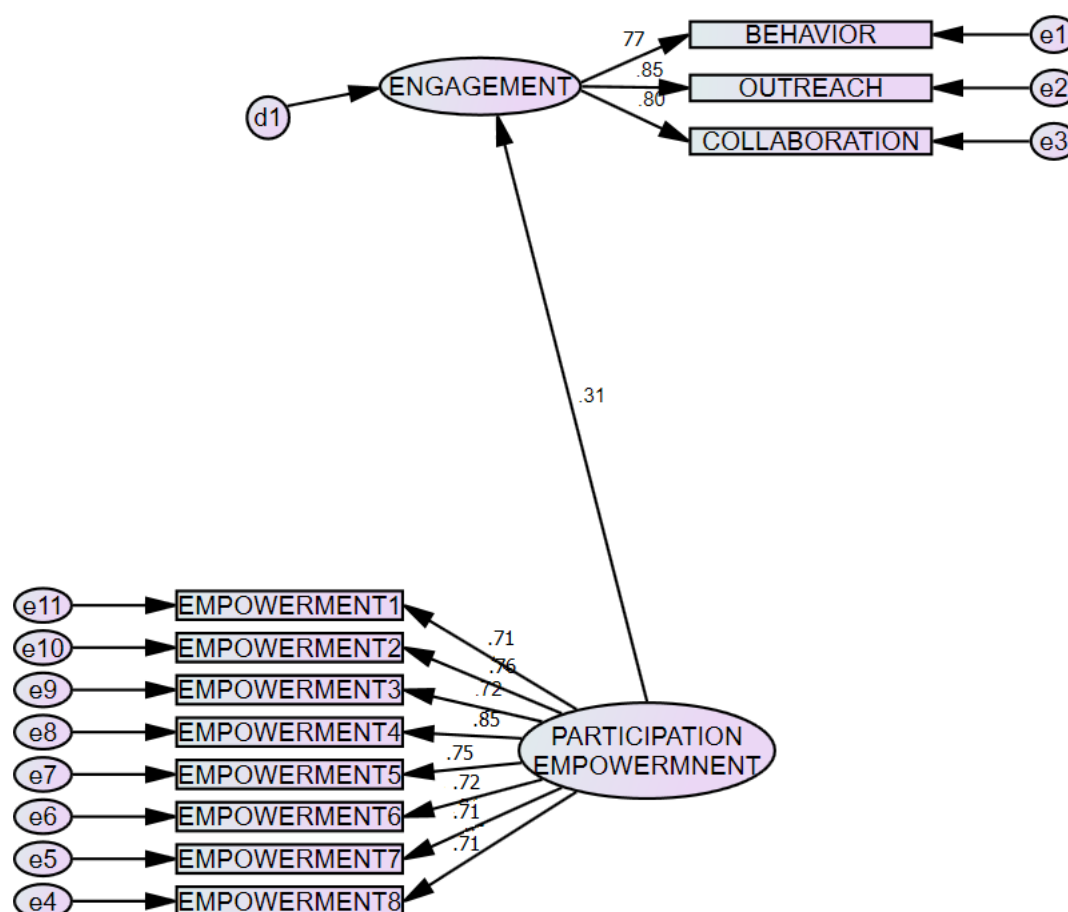


Figure 2: Structural model depicting the influence of participation and engagement on ESP.

4.2.2. H2: Information access and support empowered by digital social media is significantly associated with students' engagement in sustainability practices

Table 5 presents parameter estimates of the influence of access to information and support empowered by social media on engagement in sustainability practices.

Table 5

Parameter estimates for the effect of access to resource and support on ESP.

Exogenous	Endogenous	Estimate	Standard error	CR	<i>p</i>	<i>R</i> ²
Access to resources and support →	ESP	0.106	0.052	2.04	<.041	0.21

The study findings show that access to information and support positively influences ESP ($\beta=0.106$, $p=0.041$). In addition, the results show that 21.0% of the variation in ESP is explained by ARS ($R^2=0.210$). Furthermore, the standardised path coefficient of 0.11 in figure 3 indicates a weak but positive effect of access to resources and support on ESP, which suggests that greater access to sustainability contents and resources through social media has a small influence on ESP.

4.2.3. H3: Self-expression empowered by digital social media is significantly associated with students' engagement in sustainability practices

The study findings in table 6 show that self-expression and control empowered by social media usage have a positive influence on engagement in sustainability practices

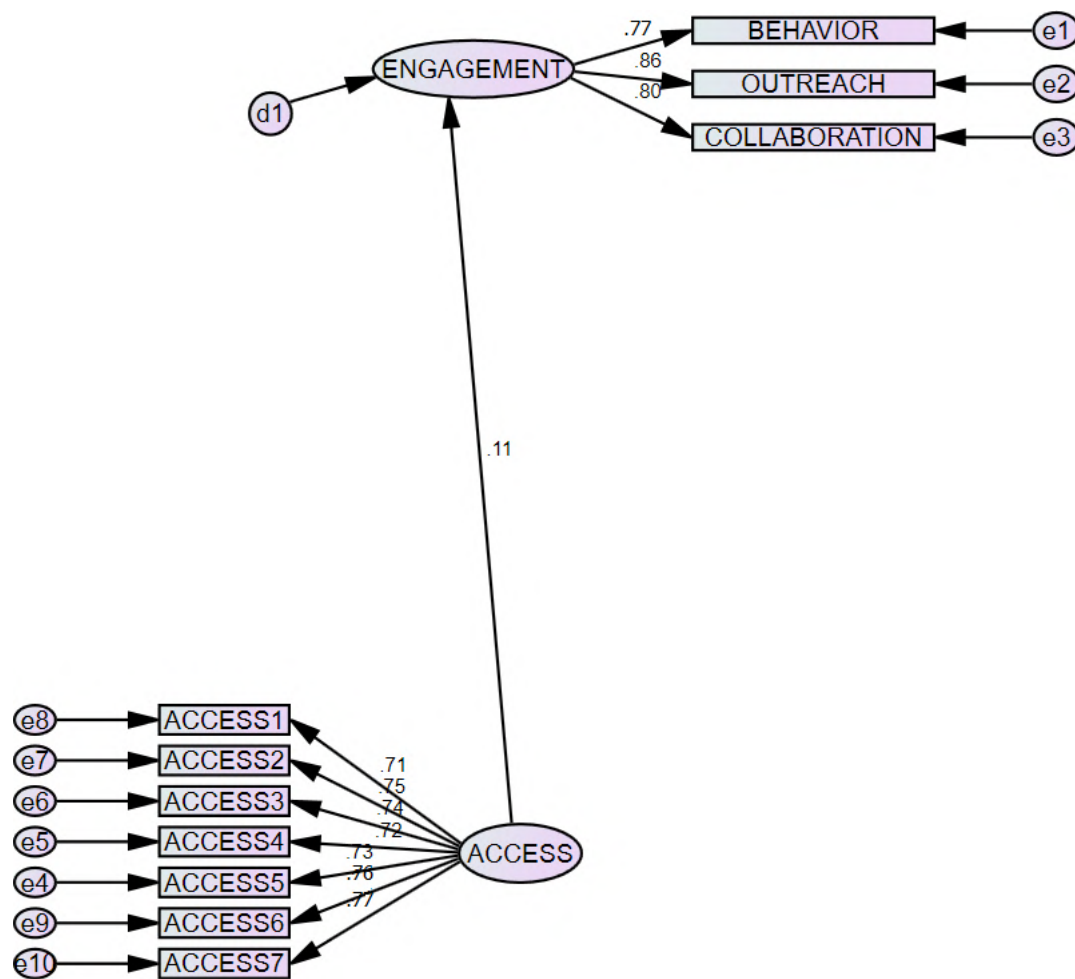


Figure 3: Structural model depicting the influence of access to resources and support on ESP.

($\beta=0.319$, $p<.0001$). These findings confirm a highly significant and moderate positive effect. Moreover, the results also show that 10.2% of the variation in engagement in sustainability practices is explained by self-expression and control ($R^2=0.102$).

Table 6

Parameter estimates for the effect of self-expression and control on ESP.

Exogenous	Endogenous	Estimate	Standard error	CR	<i>p</i>	R^2
Self-expression and control →	ESP	0.319	0.1	4.629	<.0001	0.102

As indicated in figure 4, the factor loading for access and support as an exogenous construct ranges from 0.76 to 0.89, confirming that all items strongly contribute to the exogenous variable.

The study findings depict that the standardised path coefficient (0.32) indicates a moderate positive effect of the self-exogenous variable on the endogenous variable. This suggests that greater self-expression and control empowered by social media usage have a positive but moderate influence on engagement in sustainability practices. In sum, the findings support a significant role of self-expression and control empowered by social media usage in fostering ESP.

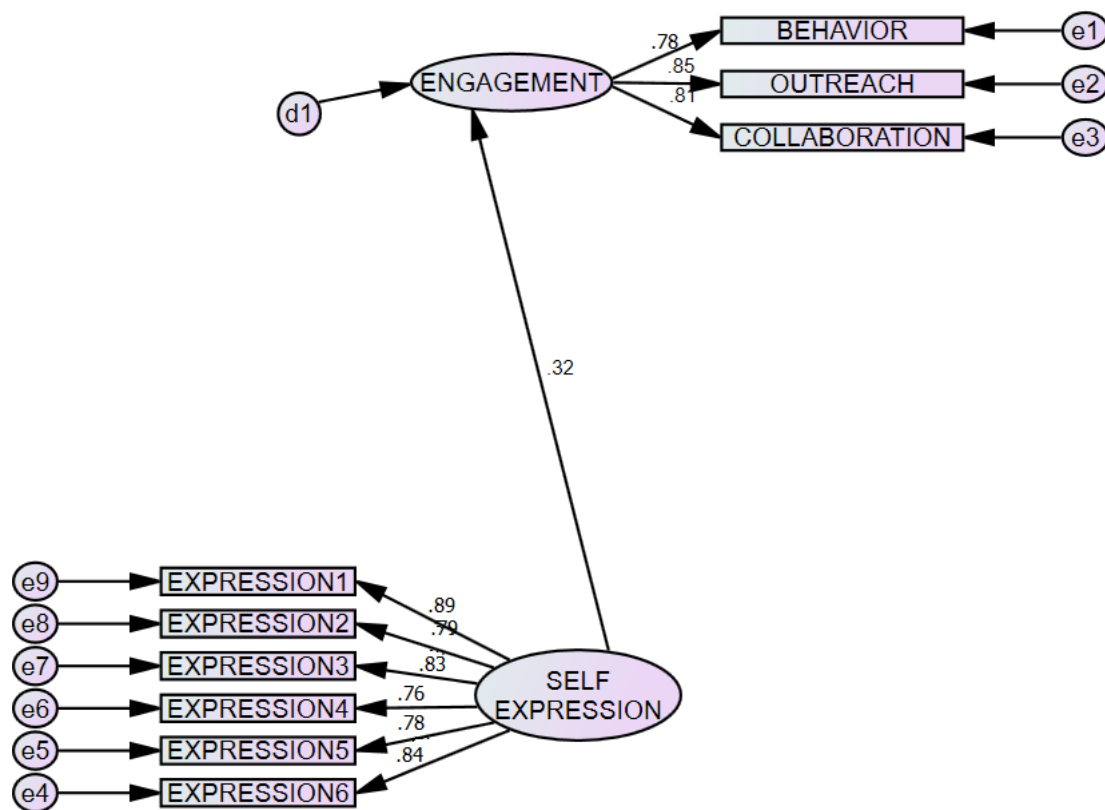


Figure 4: Structural model depicting the influence of self-expression and control on ESP.

5. Discussion and practical implications

This empirical study demonstrates how exposure to sustainability content and issues through social media can empower undergraduate students to engage in sustainability practices actively. A key contribution to the digital learning literature lies in the study's validation of a measurement model that shows how social media-enabled empowerment can predict specific dimensions of undergraduate student sustainability engagement, particularly behavioural change, community outreach and collaboration. The study findings align with the principles of empowerment theory [63, 88], emphasising that cognitive, emotional and behavioural domains shape social-psychological empowerment. On the other hand, the findings are consistent with the findings by Meng, Chung and Zhang [50], who found that exposure to environmental information on social media positively influenced individuals' intentions to engage in pro-environmental behaviour, their perceived behavioural control, pro-environmental attitudes and fear of environmental victimisation. Similarly, Hoffmann and Lutz [34] reported that perceived social media efficacy predicts civic participation, especially among youth.

On the same wavelength, the study findings revealed that, the acceptance of all three hypotheses provides strong empirical support for the argument that, participation and engagement ($\beta=0.311$, $p<.0001$, $R^2=0.469$), access to resources and support ($\beta=0.106$, $p=0.041$, $R^2=0.210$) as well as self-expression and control ($\beta=0.319$, $p<.0001$, $R^2=0.102$) as facilitated by social media, are all significantly associated with students' engagement in sustainability practices (ESP). These findings align with the core principles of empowerment theory [63, 88], which assert that individuals are more likely to engage in meaningful action when they perceive themselves as competent, autonomous and supported within their social environment. On the same note, the empowerment

dimensions examined in this study are behavioural engagement, perceived control and resource access, which correspond with psychological empowerment's cognitive, emotional and behavioural domains.

Collectively, these findings reinforce previous studies by highlighting the empowering potential of social media in educational and sustainability contexts. This is evidenced by studies carried out by Confetto et al. [16] and Scherman, Valenzuela and Rivera [68] who emphasised how participatory digital spaces, such as exposure to sustainability-related content on social media, can promote user engagement in sustainability practices. In addition, Ansari and Khan [4] as well as Shabbir, Manan and Ayaz [70] demonstrated that the use of social media for collaborative learning significantly enhances knowledge sharing, while improving users' perceived agency and self-expression in sustainability learning environments. Thus, the current study contributes to theoretical understandings of the phenomenon under study by showing that when meaningfully integrated, social media can serve as a catalyst for empowering undergraduate students to engage in sustainability practices.

The structural models provided parameter estimates and other metrics that helped to establish the differences and the extent to which undergraduate students engage in sustainability practices when influenced by each exogenous construct. The participation and engagement factor explained approximately 46.9% of the variance in ESP, indicating a moderate-to-strong explanatory power of participation and engagement empowered by social media. Furthermore, the observed role of participation and sharing as key predictors of engagement reflects earlier empirical findings showing that platform affordances and participatory culture contribute meaningfully to the development of critical sustainability competencies [37, 58, 86]. One of the practical implications of these findings is that the increase in exposure and participation in sustainability discourse on social media significantly improves students' perceived ESP.

In a similar vein, these findings concur with the findings from the study carried out by Loader, Vromen and Xenos [46], who confirmed that the power of participation is empowered by the social media environment on undergraduate students' ESP, especially in political and civil engagement. However, while participation and engagement are dependable factors, other exogenous factors, such as access to resources, support, self-expression, and control, contribute to students' ESP. On the contrary, previous studies have demonstrated that engagement with social media can be problematic due to multitasking [22, 24]. Similarly, Drody, Pereira and Smilek [24] pointed out that multitasking interferes with multiple cognitive and environmental components, subsequently fragmenting attention and reducing the depth of engagement. Likewise, Deng, Zhou and Hu [22], in their study on the personal and social factors influencing off-task, social media multitasking, emphasise the importance of considering both personal traits and social influences when exploring students' classroom engagement in a digitally saturated environment.

Although the standardised factor loadings (0.71 to 0.77) strongly define the latent construct access to resources and support, the model established a weak standardised path coefficient (0.11), indicating a weak but positive effect. This signifies that improved access to sustainability resources and support through social media has a minimal, though positive effect on students' ESP. Moreover, the findings echo the importance of holistic approaches in understanding the influence of social media empowerment on ESP. However, the findings contrast with previous studies, indicating the importance of social media in providing access to information and resources, consequently promoting behavioural change towards sustainability practices [1, 26].

The current study findings related to self-expression and control of students' ESP indicated a moderate positive effect. In this manner, the findings denote that the

improved self-expression and control, empowered by social media usage, can influence students' ESP. In light of the assertion, the study findings support the previous studies by Hu et al. [35], Monteiro and Leite [51] and the study by Theocharis et al. [77]. These studies underscore the power of social media in improving individuals' self-identity and community engagement. However, as in the current study, the self-expression and control construct explains only 10.2% of the variance in ESP, while other factors contribute more substantially to students' engagement in social-media-enabled sustainability practices. Significantly, the study findings emphasise the importance of understanding social media as the best platform that enables engagement beyond student practices on social media, to how the platform itself influences that engagement [41, 77]. Therefore, it is imperative to consider how social media interface design can influence virtual interactions that promote meaningful social connections [39].

Substantially, Kim et al. [39] affirmed that social media's utility lies in its semi-public, hybrid communication nature, involving both private and public communication norms, that can significantly influence user empowerment and engagement. This underscores the importance of paying attention to online interpersonal communication's specific nature and challenges. One of these limitations is context collapse, which results from ambiguities in audience and communicative intent because users may be unaware of their exact audience, leading to mixed-audience exposure and self-censorship [47]. In such situations, users may experience information overload, leading to fragmented attention and reduced ability to recall specific messages [59].

Moreover, engaging with sustainability practices across multiple platforms can sometimes generate conflicting discourses, such as balancing human rights advocacy with recreational or entertainment content, as what Pandit et al. [58] describes as navigating tensions between visibility and authenticity on social media. For that reason, apart from the communicated content, the design and nature of online communication environments can shape or limit undergraduate students' perceived empowerment and actual ESP as anticipated [15]. In addition, a lack of knowledge and skills to deal with a huge amount of information created on social media platforms by different content creators can hinder the perceived usefulness of social media in promoting sustainable practices.

Generally, the strong positive predictive relationship between empowerment factors and engagement in sustainability practices through social media use suggests that curriculum developers should incorporate structured opportunities for social media participation into education for sustainable development of ESD courses. This could include social media-based dialogues, digital storytelling, or student-led virtual campaigns that promote behavioural change and community engagement. Second, the demonstrated importance of self-expression and perceived control highlights the need for student-centred, flexible digital pedagogies that empower learners to take ownership of their engagement, subsequently selecting relevant platforms and formats. Third, the findings related to access to resources and peer support underscore the importance of institutional capacity-building, including providing reliable digital infrastructure, social media literacy training and safe-use guidelines, to reduce participation barriers and foster meaningful, empowered engagement.

6. Conclusion and future research

While social media have been increasingly adopted as game-changers in advancing digital pedagogy in higher education, few studies have focused on their empowering effect in improving ESP, particularly among undergraduate students. Previous studies have regularly concentrated on the broader learning context, leaving a gap in under-

standing the influence of social media empowerment in specific sustainability aspects. The present study attempted to bridge this knowledge gap by examining the impact of social media empowerment on ESP. The study examined factors such as participation and engagement, access to resources and support and self-expression and control, which confirm that social media empower users to engage in sustainability practices, though to differing magnitudes. In addition, the findings indicate the need for comprehensive approaches and strategies towards improved social media use to advance behavioural change, community outreach and collaboration, all related to ESP.

While the present study's findings generally confirm to be statistically significant regarding the influence of social media empowerment on ESP, there are some challenges related to the accuracy of information, privacy and security of social media usage [25]. Similarly, Zieba, Durst and Gonsiorowska [87] raised the challenges associated with managing knowledge and information through social media since it is a common practice for users to share their views or different topics on a single platform. This requires users' skills, knowledge, and passion for sustainability issues; otherwise, the posited issues might pass unnoticed. Therefore, the credibility of information should be subjected to social media network analysis, which requires users' knowledge on social media analysis aspects, including who knows whom, and who shares what information and knowledge with whom through which media [82].

Moreover, by employing a cross-sectional survey design, the present study was delimited to assessing the effect of social media empowerment on sustainability practices among undergraduate students sampled from a single higher learning institution in Tanzania. Given the specific country and institutional context detailed in the methodology section, the ability to generalise the findings beyond this setting was fundamentally not broad enough. Consequently, this delimitation highlights the need for further research that can build upon the current study's findings, addressing broader contexts and diverse student populations.

Future research can build on the findings of this cross-sectional quantitative study in several ways. First, an explanatory sequential mixed-methods approach is recommended to deepen understanding of the quantitative results. This would allow exploring undergraduate students' contextual and lived experiences regarding social media empowerment and sustainability engagement. Second, as this study was carried out at a single university, a multi-institutional study could provide richer insights into how different institutional environments influence outcomes and improve the generalizability of findings. Third, future research could extend the focus to undergraduate students in other academic disciplines beyond teacher education to examine how disciplinary orientation shapes digital empowerment and sustainability engagement. Finally, studies focusing on platform-specific effects, such as Facebook versus WhatsApp, could show how social media platforms mediate the relationship between online engagement and sustainability practices.

Data availability statement: Data supporting the findings of this study is available from the corresponding author upon request through: email groupsae215@gmail.com

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