Online-Journals.org

iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 18 No. 6 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijim.v18i06.47941

PAPER

Prospective Science Student Teachers' Online Learning Environment Experiences: Measurement Based on the Net Promoter Score

Muhamad Arif Mahdiannur(✉), Martini, Dyah Astriani, Laily Rosdiana, An Nuril Maulida Fauziah

Universitas Negeri Surabaya, Surabaya, Indonesia

muhamadmahdiannur@unesa.ac.id

ABSTRACT

Personalization is used in online learning to help students achieve SDG 4.C and Education 4.0 indicators. Not many studies have revealed prospective science student teachers' online learning experiences. A good experience will provide positive and constructive self-knowledge for prospective science student teachers in designing 21st-century digital learning. This study aimed to inquire into prospective science student teachers' views on online learning using the Net Promoter Score survey. This study involved 29 prospective science student teachers at one of the public universities in Indonesia. This study revealed that online learning provides freedom to express opinions and ideas freely, helps evaluate learning outcomes, online educational resources help understand the contents, and online simulations help understand concepts. The negative experiences in the online learning environment include the lack of interaction with lecturers, online learning has not yet built creative, innovative, and critical thinking skills and has not supported competency development. There is a significant difference between positive and negative online learning experiences, demonstrating how experiences can impact future teacher conception. Based on our findings, recommendations were provided to assist university lecturers in creating and designing an online learning environment to develop the professional competencies of prospective science student teachers.

KEYWORDS

online learning, prospective science student teachers, net promoter score, initial teacher education

1 INTRODUCTION

One of the Sustainable Development Goal (SDG) 4 programs in the field of education quality is SDG 4.C, which focuses on providing qualified teachers by 2030, so it is necessary to motivate young people to want to become teachers (micro-level

Mahdiannur, M.A., Martini, Astriani, D., Rosdiana, L., Fauziah, A.N.M. (2024). Prospective Science Student Teachers' Online Learning Environment Experiences: Measurement Based on the Net Promoter Score. *International Journal of Interactive Mobile Technologies (iJIM)*, 18(6), pp. 112–125. https://doi.org/10.3991/ijim.v18i06.47941

Article submitted 2023-12-14. Revision uploaded 2024-01-19. Final acceptance 2024-01-22.

target) and provide educational institutions that facilitate the development of qualified teachers (meso-level target) [1]. In line with Education 4.0 [2], online learning has become one of the most popular learning modes in higher education with its flexible, independent, and easy accessibility characteristics [3]–[6]. The widespread use of online learning in various higher education institutions is also inseparable from the COVID-19 pandemic [7]–[11]. Post-pandemic, many universities offer online courses, and online learning has become a prominent research field [5], [12]. This is also supported by the massive development of educational technology, which allows the creation of an online learning climate that transforms academic lectures [13]–[15]. Many higher education institutions have developed learning management systems to accommodate online learning. Although online learning is becoming more prominent and widely used, the problems related to it are also high.

On the other hand, prospective student science teachers hold two critical roles, namely, as learners and educators in the future. Their experiences as students, especially those related to the online learning environment, will have an impact on their professional competence as future educators. The experience of online learning practices will have an impact on the self-development and professional competence of prospective educators [16]. Initial Teacher Education plays an important role in responding to professional learning needs for the professional development of future teachers [17]. Experience as a learner in a positive online learning environment will provide greater opportunities for prospective student science teachers to design and develop personalized learning that is characteristic of 1:1 digital learning in the future [18].

Science learning, especially physics, biology, and chemistry, is not easily done online due to substantive and procedural concepts. In addition, instructors (lecturers) may not have the necessary skills to use the equipment required for online teaching [11], [19]. Instructors or lecturers tend to be adaptable to online learning when teaching substantive concepts but have challenges when it comes to designing experimental activities [20]. Experimentation is closely related to hands-on skills in the laboratory [21], and this is difficult to do in an online learning environment [22]. Conventional wisdom has been that real laboratory practice is better than virtual laboratory practice. However, with the development of educational technology, it is possible that online classes and laboratories will replace physical laboratories in the future [6].

The experience as a learner when interacting with the online learning features prepared by the instructor or lecturer more or less shapes the conception of the online learning environment for users. Research shows that STEM online learning has an effect on learners' performance and learning outcomes [22]. On the other hand, each instructor also has a different level of mastery of the online learning features and systems used [11], [19], which will form a variety of unique experiences for learners. This varied personalization of online learning will also cause a "mixing of conceptions" to form a concept scheme of "online learning environment" based on the learners' experience. Digital learning personalization is basically divided into four categories: (1) system-based; (2) network-based; (3) individually-based; and (4) hybrid approaches [23]. The personalized online learning (whether intentional or not) also affects the learners' trust that their organization/institution provides online learning that is tailored to the needs and experiences of users, which will form the conception of authority in the education system [24], [25].

User experience, especially for students of higher education services, is usually used as a parameter related to the quality of higher education [26], [27]. One of the leading indicators currently used is the Net Promoter Score (NPS). Since 2003, NPS has been used to measure customer satisfaction and loyalty in the industrial world and has been widely used as an indicator of growth in an organization [28]–[30]. This study is intended to adapt NPS to assess the perceptions of science student teachers about the online learning experience. The use of NPS as a user satisfaction measurement instrument at the Higher Education Institution level is still limited, and few research use the NPS group to assess the perceptions of prospective student science teachers regarding their experience of the online learning environment. This study focused on three research questions, namely:

a) What are the positive online learning environments perceived by prospective student science teachers?
b) What are the negative online learning environment experiences according to the perceptions of prospective student science teachers?
c) Are there differences in positive and negative experiences in online learning according to the perceptions of prospective student science teachers?

2 METHOD

2.1 Design

This study was a cross-sectional survey based on an online survey platform [31]–[33]. The Microsoft Forms platform was chosen because it provides the NPS option. This study focused on three categories based on NPS responses (promoters, passives, and detractors) to evaluate prospective student science teachers' experience of the online learning environment.

2.2 Participant

This study targets prospective student science teachers who have experienced online learning. We chose one of the public universities that has an Undergraduate Program in Science Education in Surabaya City. The inclusion criteria in this study are prospective student science teacher students in the 3rd year (junior) who have had online learning experience for at least four semesters. Exclusion criteria were prospective student science teacher students who met the inclusion criteria but did not complete the questionnaire until the deadline. A total of 29 people participated in this study. All information related to participants was anonymized, and research data management was done according to FAIR principles [34]. Table 1 shows the demographic information for the participants.

Table 1. Participants' demographic data

Characteristics		Percentage (%)
Ages range	17–19 years old	24.14
	20–22 years old	75.86
Area of origin	Urban	20.69
	Rural	79.31
Online learning experiences	Prior to the COVID-19 pandemic	3.45
	During the COVID-19 pandemic	96.55

2.3 Instrument

The instrument for this study was an online learning-related questionnaire based on the NPS scale (0 to 10) with a range of anchor choices, namely "extremely unlikely" and "extremely likely" [29], [30]. The instruments were adapted from the online learning effectiveness questionnaire [35], the student satisfaction and performance questionnaire in online classes [36], and the online learning process questionnaire (OLPQ) [37]. Table 2 shows the questionnaire items used to investigate online learning experiences.

Table 2. Online learning experience questionnaire instrument

Code	Statements
S1	Online learning gives freedom to express personal ideas/opinions
S2	Online learning is helpful in evaluating learning outcomes
S3	The videos, images, and learning materials (textbooks/slides) provided are very helpful for understanding the contents
S4	Virtual experiments/simulations are very helpful in understanding scientific concepts
S5	Interaction with teachers in online learning
S6	Online learning facilitates creativity/innovation development
S7	Online learning helps develop critical thinking skills
S8	Online learning facilitates competency development as a prospective student science teacher

2.4 Data collection and analysis techniques

A cross-sectional survey was conducted among participants who met the inclusion criteria by sending an email with a link to an online questionnaire (Microsoft Forms). Participants were given a four-week time limit for completion. The link to the online questionnaire was sent in early May 2023. Participants' responses were categorized into three groups (promoters, passives, and detractors), and NPS was calculated based on the percentage difference between the fraction of promoters and detractors [29], [30], [38]. A positive NPS indicates that the participants had a positive experience, while a negative NPS indicates that the participants' expectations were not met. The reliability of the survey results used Cronbach's alpha and McDonald's omega criteria with a range ≥ 0.70 [39]. Participants' responses were analyzed using descriptive statistics based on boxplot graphs, while the differences in positive and negative experiences in online learning were analyzed using the Bayesian paired t-test approach by fulfilling the assumptions of normally distributed datasets and homogeneous variances of both datasets [40].

3 FINDINGS

Participants responded on average in the range of 6.55–8.55. The median range of participants' responses was on a scale of 7–9. Statement coded S1 had a response distribution that had greater variance when compared to the other seven statements. This result shows that participants' experiences vary regarding the online learning environment, which facilitates freedom in expressing personal ideas and opinions. For participants who like to express their opinions directly, it is certainly not easy to express their opinions through text, but for introverted participants, it will be easier to write down their personal ideas and opinions in online learning. The lowest average participant response is on statement code S5, which is interaction with a lecturer or instructor in online learning. Statement code S4, i.e., virtual experiments or simulations are very helpful to understand scientific concepts, got the highest average response. Interaction in online learning often becomes a scourge because the majority of online learning conducted is emergency remote teaching [41], so the teachers do not have the knowledge and experience of online learning design [42]. In contrast, the use of virtual experiments and simulations had positive effects on the participants. The utilization of online laboratories has the potential to develop science inquiry skills [6], [43]. Figure 1 displays the data distribution of participants' responses to the eight items of the online learning experience questionnaire.

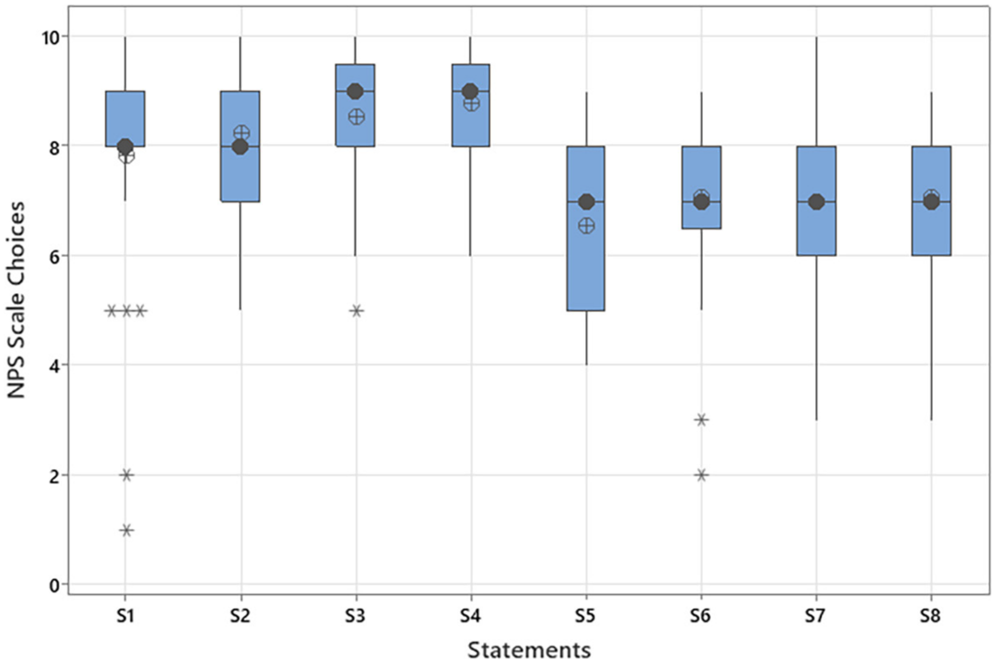


Fig. 1. Boxplot of participant's choice distribution

Participants' experience of the learning environment was based on statistical NPS. All participants' responses were categorized into three categories: promoters, passives, and detractors. A summary of the response NPS data related to the online learning environment is presented in Table 3.

Table 3. Online learning environment responses by NPS

Data	Statements							
	S1	S2	S3	S4	S5	S6	S7	S8
Promoters (%)	48.28	48.28	65.52	68.97	3.45	13.79	10.34	20.69
Passives (%)	34.48	41.38	24.14	27.59	55.17	62.07	55.17	41.38
Detractors (%)	17.24	10.34	10.34	3.45	41.38	24.14	34.48	37.93
NPS	31.03	37.93	55.17	65.52	–37.93	–10.34	–24.14	–17.24
SD	0.75	0.67	0.67	0.54	0.55	0.61	0.62	0.75
SE	0.14	0.12	0.13	0.10	0.10	0.11	0.12	0.14

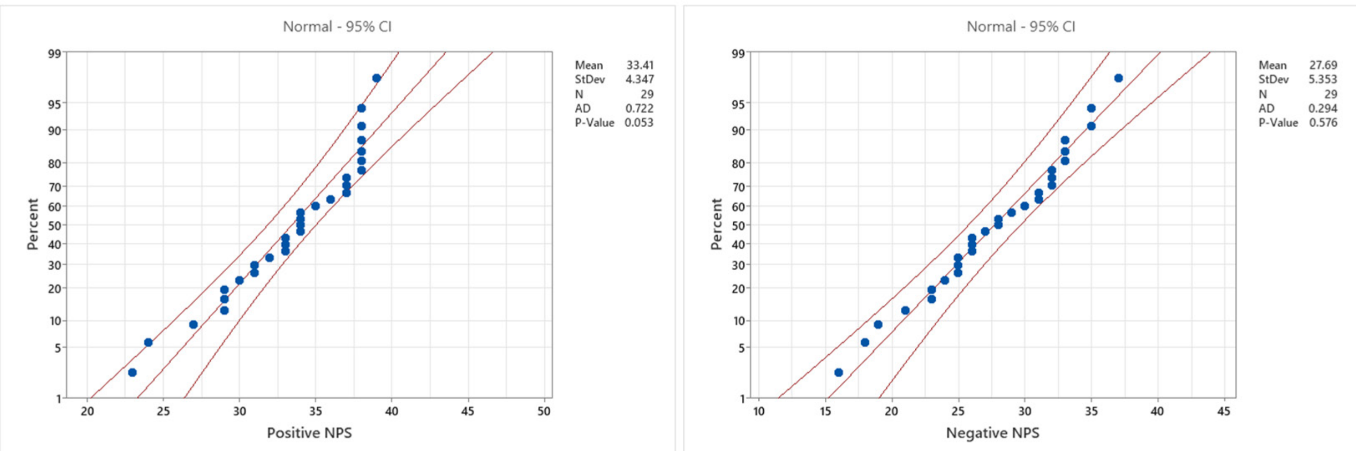
Table 3 shows that statements S1, S2, S3, and S4 have positive NPS, while statements S5, S6, S7, and S8 have negative NPS. According to the participants, online learning has supported freedom in expressing personal ideas and opinions, helped evaluate learning outcomes, utilized videos, images, learning materials (textbooks/slides), and conducted online experiments and simulations that are very helpful in understanding scientific concepts. In contrast, online learning has not been able to facilitate the development of creativity/innovation, critical thinking skills, and competence as prospective science student teachers.

The results of participant responses and the resulting NPS statistics need to be seen for their reliability. Based on the calculation, the Cronbach's alpha coefficient is 0.852 and the McDonald's omega coefficient is 0.862. These results indicate that the reliability coefficient meets the criteria, which is ≥ 0.70 [39]. The use of NPS as a scale to measure experience based on satisfaction with the online learning environment is very effective. In addition, the results of the reliability calculation also show that there is no bias from latent variables. Table 4 shows the reliability of the participant's responses on the NPS scale based on Cronbach's alpha and McDonald's omega.

Table 4. Results of reliability measurement

Estimate	Cronbach's Alpha	McDonald's Omega
Point estimate	0.852	0.862
95% CI lower bound	0.782	0.779
95% CI upper bound	0.902	0.921

The experience of the online learning environment based on the results in Table 3 shows an extreme dichotomy. This dichotomy difference is based on the NPS score cluster (positive and negative). The probability of the difference between these two experiences needs to be known to ascertain whether this discrepancy is significant or not. The results of testing the distribution and homogeneity of variance of the two datasets (positive and negative NPS) are presented in Figure 2 and Table 5.



(a) (b)

Fig. 2. Dataset probability plot (a) positive NPS clusters; (b) negative NPS clusters

Based on the data in Figure 2, it can be seen that the positive NPS and negative NPS datasets have a p-value > 0.05. Both the positive NPS cluster dataset (*AD* = 0.722, *p* = 0.053) and the negative NPS cluster (*AD* = 0.294, *p* = 0.576) are normally distributed. These distribution results also indicate that the distribution of data is in accordance with the estimated reliability of the instrument used. In addition, the results of the data analysis obtained can also be inferred from a larger population, or, in other words, can be generalized generally, provided that they are in accordance with predetermined criteria. A comparison of the variance of the two datasets based on the Levene test also shows a p-value > 0.05, which means that the variance of the two cluster datasets (positive and negative NPS) is homogeneous (see Table 5).

Table 5. Dataset variance homogeneity test results

Method	Test Statistic	df_1	df_2	p-Value
Levene	1.68	1	56	0.200

The Bayesian paired t-test does not contradict the assumptions based on the results from determining the normality and homogeneity of the positive and negative NPS cluster datasets [37]. Table 6 and Figure 3 show the results of the likelihood of difference based on the Bayesian paired t-test.

Table 6. Bayesian paired t-test results

Measure 1		Measure 2	BF_{10}	Error %
Positive NPS Cluster	–	Negative NPS Cluster	119907.139	7.537×10^{-11}

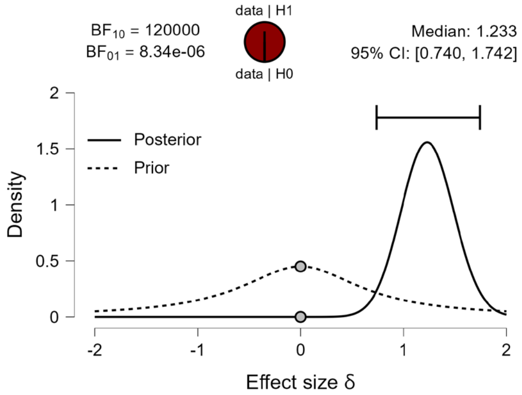


Fig. 3. Prior and posterior distribution based on effect size

According to Table 6, the alternative hypothesis, namely that there is an effect size not equal to zero (H_1), has a probability of 120,000 times or that there is a difference between the positive NPS cluster and the negative NPS cluster dataset groups, has a chance of 120,000 times. The error % is also smaller than the threshold criterion, which is 10%, indicating that the accuracy of the Bayes calculation is very thorough. Referring to the BF_{10} value, it can be concluded that there is very strong evidence, according to Jeffrey's criteria [40], that there is a difference between the two NPS clusters in the experience of the online learning environment. This evidence is also corroborated based on the prior and posterior distribution plots in Figure 3. The resulting pizza plot distribution is entirely red. This means that there is a very high chance of a very strong difference between the two datasets being compared [40].

In addition, the grey dot of the prior distribution is positioned above the grey dot of the posterior distribution at a 0.0 effect size, which means that the chance of BF_{10} occurring is greater than BF_{01}. The prior and posterior distributions based on the NPS cluster dataset (positive and negative) have shifted towards a positive effect size. The median effect size is > 1 ($\delta = 1.233$), which indicates a strong effect, and the credibility interval (CI) is in the positive range (95% CI: (0.740, 1.742)).

4 DISCUSSION

The significant difference between positive and negative NPS clusters has serious implications for developing policy directions related to the design of online learning environments. Referring to one of the demographic data characteristics in Table 1, the majority of participants only experienced online learning after the COVID-19 pandemic and required large-scale social restrictions. The experience of emergency remote teaching and learning for two years also led to the conception of online learning itself. Online learning had an effect on updating learning styles, content, concepts, levels, and assessments during the pandemic, and it can have an impact on how modern learners see the digital world [44], [45]. Besides, many studies have revealed that the interaction of learners with the learning environment occurs through at least three things: behavioral engagement, cognitive engagement, and attitude towards online learning [4]. These interactions are also closely related to learners' digital skills to maximize all features of online learning [13], [46].

Many educational technology features and learning activity designs have been developed to support online learning [14]. Among them are various online learning personalization designs, online laboratory and experiment simulations, open educational resources, and systems [6], [13], [14], [43]. The results of this research show that the learners have no problems related to the learning resource features in the form of videos, images, learning materials (textbooks/slides), and experiments/simulations. They also generally do not have problems related to the freedom to express personal opinions in the online learning environment. The learners are also greatly helped in evaluating the learning outcomes through formative assessment (assessment as learning) in the form of a quiz or test, which, after submission, displays the score obtained by each learner. These features provide a positive experience and perception for the learners, who are future science teachers.

On the other hand, according to the perspective of prospective science student teachers, the experience of an online learning environment has not facilitated their development of creativity and innovation, critical thinking skills, and professional competence as future science educators. Based on the constructivist view, learners in online/virtual learning environments create knowledge through interactions among fellow learners, teachers, and the environment at a broader level of autonomy [37], [47]. Lecturers have rarely been equipped with instructional techniques in online learning environments, even though the role of lecturers in designing online learning in line with pedagogical goals is vital [48]. So far, the majority of lecturers are still dominated by "teacher/content-focused conceptions" [49]. This means that not all features in the online learning environment are used to create an online learning activity that can facilitate the development of creativity, innovation, and critical thinking skills.

Knowledge itself is a multifaceted understanding that influences perception based on prior knowledge. This result is consistent with previous research findings that learners' perceptions of online learning will affect online learning readiness and have an effect on learners' performance and satisfaction with the online learning environment [5]. The role of instructors or teachers is very important in providing support and scaffolding that suit the needs of learners. The support that students get through human contact is still very important, even in an online learning environment. Experts argue based on recent research that pedagogical support of learners is one of the most vital aspects of online education [47]. Furthermore, the Education 4.0 era emphasizes the role of educators as facilitators in developing educational technology-based learning that may assist in the development of complex thinking skills such as systemic thinking, scientific thinking, critical thinking, and innovative thinking [14].

The current educational megatrend is divided into three categories: participation/interaction in learning, a fun learning atmosphere, and personalization of learning [14], [23]. Online learning is associated with technological advancement, time, and the synonymity of terms in online learning [50]. In addition, technological advances will also provide online autonomy for learners to freely choose online learning modes and have implications for the creation of attractive, reinforcing, motivating, and learner-centered learning environments [51]. The role of lecturers at the tertiary level is vital in designing and facilitating online learning environments for initial teacher education. The online learning environment must be oriented towards developing creativity and innovation, critical thinking skills, and professional competencies for future science teacher candidates.

Early teacher education policy development needs to prioritize aspects of strengthening the personal and social competencies of prospective science teachers who utilize educational technology, according to Education 4.0. Based on the findings of this research, it is necessary to rethink the design of digital learning personalization for science teacher candidates. When reviewing the results of previous research, it can be concluded that there is no real evidence that offline learning works better and that online learning has the advantage of improving students' knowledge and skills [52]. Based on these considerations, the design of initial teacher education needs to combine aspects of educational technology that can facilitate the interaction of prospective science teacher students to be able to develop cognitive abilities, attitudes, behaviors, and skills (both science and digital processes). Teachers need to be trained to design a learning management system (LMS) that supports the development of creativity/innovation, critical thinking skills, and professional competence as science teachers. The three most vital aspects of online learning are discussion, motivation, and systems [5].

Discussion should not only emphasize exchanging messages or lecturers giving responses and feedback but also motivating and scaffolding in the form of a "written prompt," which is useful to guide students during the learning process. Students' intrinsic motivation also needs to be maintained and enhanced during online learning. Lecturers can utilize various features and channels for interaction with students, as well as diverse learning resources, according to the principle of personalized learning. Giving "extra credit" to active students is also one of the most important ways to boost students' motivation to keep participating in the online learning process. Another factor that should be considered is the utilization of an LMS that has a simple, easy-to-use, and attractive interface and supports easy online discussion and teamwork. The LMS should also be accessible on all types of devices (PC, tablet, or mobile phone). Furthermore, the initial teacher education design, especially for prospective science student teachers, prioritizes a combination of individual activities and group activities combined with conditional activities on the LMS. The combination of individual and group activities is expected to facilitate the development of creativity/innovation, critical thinking skills, and professional competencies as future science teachers. In addition, this online learning mode is also combined with offline learning to solidify the initial teacher education model.

A limitation of this research is that the number of participants in the passives group tends to be high, ranging from 24.14% to 62.07% (see Table 3). This passives group is different from the detractors, who are less satisfied with the online learning environment they have experienced. Basically, the passives group is a group of individuals who feel "satisfied" with the experience of all services that have been received [53]. This group of passives may feel that the expectations and hopes for the services received have merit but do not intend to promote them to others [28]. On the other hand, the number of participants involved is still small, although it has a non-zero probability of effect size and a very strong category.

5 CONCLUSION

The positive experiences of prospective student science teachers towards the online learning environment, namely that the online learning environment facilitates freedom in expressing personal opinions and helps evaluate learning outcomes, available learning resources, and the utilization of online experiments or laboratories, are very helpful in understanding substantive and procedural concepts. On the contrary, the online learning environment has not facilitated the development of creativity and innovation in learners, critical thinking skills, or the professional competencies of future science teacher students. Furthermore, there is a very strong (significant) difference in the effect size of the positive and negative experience clusters based on the cumulated NPS scale choice scores of all participants. This indicates that it is necessary to prepare a personalized design for initial teacher education, especially for teachers of STEM subjects in schools. Science teacher educators in Higher Education need to be assisted in creating and designing online learning environments to develop the professional competence of prospective student science teacher students through strengthening positive and constructive online learning experiences in developing creative thinking skills, critical thinking, and sustainable science learning innovation.

6 ACKNOWLEDGMENT

We would like to thank the Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, for their support and funding of this research through the Faculty Policy Basic Research 2023 scheme.

7 REFERENCES

[1] E. Boeren, "Understanding sustainable development goal (SDG) 4 on 'quality education' from micro, meso and macro perspectives," *Int. Rev. Educ.*, vol. 65, no. 2, pp. 277–294, 2019. https://doi.org/10.1007/s11159-019-09772-7

[2] A. Patiño, M. S. Ramírez-Montoya, and M. Buenestado-Fernández, "Active learning and education 4.0 for complex thinking training: Analysis of two case studies in open education," *Smart Learn. Environ.*, vol. 10, no. 1, p. 8, 2023. https://doi.org/10.1186/s40561-023-00229-x

[3] T. Cao, Z. Zhang, W. Chen, and J. Shu, "Utilizing clickstream data to reveal the time management of self-regulated learning in a higher education online learning environment," *Interact. Learn. Environ.*, pp. 1–18, 2022. https://doi.org/10.1080/10494820.2022.2042031
[4] F. Hisey, T. Zhu, and Y. He, "Use of interactive storytelling trailers to engage students in an online learning environment," *Act. Learn. High. Educ.*, p. 146978742211075, 2022. https://doi.org/10.1177/14697874221107574
[5] H.-C. Wei and C. Chou, "Online learning performance and satisfaction: Do perceptions and readiness matter?" *Distance Educ.*, vol. 41, no. 1, pp. 48–69, 2020. https://doi.org/10.1080/01587919.2020.1724768
[6] D. O. Obada *et al.*, "Teaching bioengineering using a blended online teaching and learning strategy: A new pedagogy for adapting classrooms in developing countries," *Educ. Inf. Technol.*, vol. 28, no. 4, pp. 4649–4672, 2023. https://doi.org/10.1007/s10639-022-11330-y
[7] I. Zitha, M. G. Mokganya, and T. Manyage, "Integration of blended learning in the advent of COVID-19: Online learning experiences of the science foundation students," *Educ. Sci.*, vol. 13, no. 7, p. 704, 2023. https://doi.org/10.3390/educsci13070704
[8] M. E. Khalaf, N. H. Abubakr, and H. Ziada, "Students' experience of online learning in a blended learning setting: A qualitative evaluation," *Educ. Sci.*, vol. 13, no. 7, p. 725, 2023. https://doi.org/10.3390/educsci13070725
[9] J. Xie, G. A, M. F. Rice, and D. E. Griswold, "Instructional designers' shifting thinking about supporting teaching during and post-COVID-19," *Distance Educ.*, vol. 42, no. 3, pp. 331–351, 2021. https://doi.org/10.1080/01587919.2021.1956305
[10] Y. Cao, "Understanding Chinese students' online learning experiences with emergency remote teaching: A case study," *Asia Pac. J. Educ.*, pp. 1–19, 2023. https://doi.org/10.1080/02188791.2023.2206548
[11] D. J. O'Brien, "A guide for incorporating e-teaching of physics in a post-COVID world," *Am. J. Phys.*, vol. 89, no. 4, pp. 403–412, 2021. https://doi.org/10.1119/10.0002437
[12] A. Jain, P. Sharma, and J. R. Meher, "Effects of online platforms on learner's satisfaction: A serial mediation analysis with instructor presence and student engagement," *Int. J. Inf. Learn. Technol.*, 2023. https://doi.org/10.1108/IJILT-02-2023-0017
[13] A. R. Das and A. Bhattacharyya, "Is STEM a better adaptor than non-STEM groups with online education: An Indian peri-urban experience," *Asian Assoc. Open Univ. J.*, vol. 18, no. 1, pp. 20–33, 2023. https://doi.org/10.1108/AAOUJ-07-2022-0092
[14] M. Diao and J. G. Hedberg, "Mobile and emerging learning technologies: Are we ready?" *Educ. Media Int.*, vol. 57, no. 3, pp. 233–252, 2020. https://doi.org/10.1080/09523987.2020.1824422
[15] N. Nonthamand, "Development of an online learning lesson in the educational technology equipment operation course for pre-service teachers," *Int. J. Interact. Mob. Technol. IJIM*, vol. 17, no. 10, pp. 30–46, 2023. https://doi.org/10.3991/ijim.v17i10.37775
[16] M. L. Wadams and K. Schick-Makaroff, "Teaching assistant development and contributions in online, MOOC and blended synchronous settings: An integrative review," *J. Furth. High. Educ.*, vol. 46, no. 8, pp. 1023–1039, 2022. https://doi.org/10.1080/0309877X.2022.2038100
[17] J. Charteris *et al.*, "Patchworks of professional practices: Teacher collaboration in innovative learning environments," *Teach. Teach.*, vol. 27, no. 7, pp. 625–641, 2021. https://doi.org/10.1080/13540602.2021.1983536
[18] S. E. Bryans-Bongey, "From digital distraction to digital direction: Implementing Interactive agendas in the 1:1 classroom environment," *J. Educ. Technol. Syst.*, vol. 49, no. 3, pp. 341–354, 2021. https://doi.org/10.1177/0047239520982262
[19] D. J. Lemay, P. Bazelais, and T. Doleck, "Transition to online learning during the COVID-19 pandemic," *Comput. Hum. Behav. Rep.*, vol. 4, p. 100130, 2021. https://doi.org/10.1016/j.chbr.2021.100130

[20] R. Leinonen, M. H. P. Kesonen, and M. A. Asikainen, "Finnish university physics teachers' experiences of transferring to online teaching due to COVID-19 pandemic," *SN Soc. Sci.*, vol. 3, no. 4, p. 68, 2023. https://doi.org/10.1007/s43545-023-00647-1

[21] A. M. Elkhatat and S. A. Al-Muhtaseb, "Hybrid online-flipped learning pedagogy for teaching laboratory courses to mitigate the pandemic COVID-19 confinement and enable effective sustainable delivery: Investigation of attaining course learning outcome," *SN Soc. Sci.*, vol. 1, no. 5, p. 113, 2021. https://doi.org/10.1007/s43545-021-00117-6

[22] E. Idrizi, S. Filiposka, and V. Trajkovikj, "Gender impact on STEM online learning-a correlational study of gender, personality traits and learning styles in relation to different online teaching modalities," *Multimed. Tools Appl.*, vol. 82, no. 19, pp. 30201–30219, 2023. https://doi.org/10.1007/s11042-023-14908-x

[23] H. Fake and N. Dabbagh, "Personalized learning within online workforce learning environments: Exploring implementations, obstacles, opportunities, and perspectives of workforce leaders," *Technol. Knowl. Learn.*, vol. 25, no. 4, pp. 789–809, 2020. https://doi.org/10.1007/s10758-020-09441-x

[24] J. L. Scott, G. Knezek, J. R. Poirot, and L. Lin-Lipsmeyer, "Attributes of learning organizations: Measuring personalized online learning and alternative credentials as part of a learning culture," *TechTrends*, vol. 67, no. 1, pp. 54–67, 2023. https://doi.org/10.1007/s11528-022-00773-2

[25] A. Klašnja-Milićević, M. Ivanović, B. Vesin, and Z. Budimac, "Enhancing e-learning systems with personalized recommendation based on collaborative tagging techniques," *Appl. Intell.*, vol. 48, no. 6, pp. 1519–1535, 2018. https://doi.org/10.1007/s10489-017-1051-8

[26] C. Munteanu, C. Ceobanu, C. Bobâlcă, and O. Anton, "An analysis of customer satisfaction in a higher education context," *Int. J. Public Sect. Manag.*, vol. 23, no. 2, pp. 124–140, 2010. https://doi.org/10.1108/09513551011022483

[27] A. Kanwar and M. Sanjeeva, "Student satisfaction survey: A key for quality improvement in the higher education institution," *J. Innov. Entrep.*, vol. 11, no. 1, p. 27, 2022. https://doi.org/10.1186/s13731-022-00196-6

[28] K. S. Lucero, "Net promoter score (NPS): What does net promoter score offer in the evaluation of continuing medical education?" *J. Eur. CME*, vol. 11, no. 1, p. 2152941, 2022. https://doi.org/10.1080/21614083.2022.2152941

[29] A. Kara, A. Mintu-Wimsatt, and J. E. Spillan, "An application of the net promoter score in higher education," *J. Mark. High. Educ.*, pp. 1–24, 2022. https://doi.org/10.1080/08841241.2021.2018088

[30] A. Kara and D. Zeren, "The relationship between the Net Promoter Score (NPS) and students' college experiences at a state university," *Int. Rev. Public Nonprofit Mark.*, 2022. https://doi.org/10.1007/s12208-022-00352-4

[31] J. R. Fraenkel, N. E. Wallen, and H. H. Hyun, *How to design and evaluate research in education*. New York, NY: McGraw-Hill, 2023.

[32] K. El Bairi, M. Fourtassi, R. El Fatimy, and N. El Kadmiri, "Distance education as a tool to improve researchers' knowledge on predatory journals in countries with limited resources: The Moroccan experience," *Int. J. Educ. Integr.*, vol. 19, no. 1, p. 1, 2023. https://doi.org/10.1007/s40979-023-00122-7

[33] Y. Yang, K. Liu, M. Li, and S. Li, "Students' affective engagement, parental involvement, and teacher support in emergency remote teaching during the COVID-19 pandemic: Evidence from a cross-sectional survey in China," *J. Res. Technol. Educ.*, vol. 54, no. sup1, pp. S148–S164, 2022. https://doi.org/10.1080/15391523.2021.1922104

[34] M. D. Wilkinson *et al.*, "The FAIR guiding principles for scientific data management and stewardship," *Sci. Data*, vol. 3, no. 1, p. 160018, 2016. https://doi.org/10.1038/sdata.2016.18

[35] P. S. H. Darius, E. Gundabattini, and D. G. Solomon, "A survey on the effectiveness of online teaching–learning methods for university and college students," *J. Inst. Eng. India Ser. B*, vol. 102, no. 6, pp. 1325–1334, 2021. https://doi.org/10.1007/s40031-021-00581-x

[36] R. Gopal, V. Singh, and A. Aggarwal, "Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID-19," *Educ. Inf. Technol.*, vol. 26, no. 6, pp. 6923–6947, 2021. https://doi.org/10.1007/s10639-021-10523-1

[37] J. H. Y. Lam and S. X. Tong, "Development and validation of the online learning process questionnaire (OLPQ) at home for primary-school children and their caregivers," *Learn. Environ. Res.*, vol. 26, no. 2, pp. 515–538, 2023. https://doi.org/10.1007/s10984-022-09443-9

[38] B. Rocks, "Interval estimation for the 'net promoter score,'" *Am. Stat.*, vol. 70, no. 4, pp. 365–372, 2016. https://doi.org/10.1080/00031305.2016.1158124

[39] L. Lunde *et al.*, "Evidence of validity for the Norwegian version of the interprofessional collaborative competency attainment survey (ICCAS)," *J. Interprof. Care*, vol. 35, no. 4, pp. 604–611, 2021. https://doi.org/10.1080/13561820.2020.1791806

[40] J. Van Doorn *et al.*, "The JASP guidelines for conducting and reporting a Bayesian analysis," *Psychon. Bull. Rev.*, vol. 28, no. 3, pp. 813–826, 2021. https://doi.org/10.3758/s13423-020-01798-5

[41] O. B. Adedoyin and E. Soykan, "COVID-19 pandemic and online learning: The challenges and opportunities," *Interact. Learn. Environ.*, vol. 31, no. 2, pp. 863–875, 2023. https://doi.org/10.1080/10494820.2020.1813180

[42] B. Azhari and I. Fajri, "Distance learning during the COVID-19 pandemic: School closure in Indonesia," *Int. J. Math. Educ. Sci. Technol.*, vol. 53, no. 7, pp. 1934–1954, 2022. https://doi.org/10.1080/0020739X.2021.1875072

[43] X. Kuang, T. H. S. Eysink, and T. Jong, "Effects of providing partial hypotheses as a support for simulation-based inquiry learning," *J. Comput. Assist. Learn.*, vol. 36, no. 4, pp. 487–501, 2020. https://doi.org/10.1111/jcal.12415

[44] P. Chatwattana, "Massive open online courses model with self-directed learning to enhance digital literacy skills," *Int. J. Eng. Pedagogy IJEP*, vol. 11, no. 5, pp. 122–137, 2021. https://doi.org/10.3991/ijep.v11i5.22461

[45] S. B. Seryakova, X. Zhang, O. V. Galustyan, N. N. Askhadullina, T. V. Pushkareva, and E. V. Zvonova, "Application of online learning within education of future engineers during the COVID-19 pandemic," *Int. J. Eng. Pedagogy IJEP*, vol. 12, no. 1, pp. 95–103, 2022. https://doi.org/10.3991/ijep.v12i1.25009

[46] S. Al Salman, M. Alkathiri, and A. Khaled Bawaneh, "School off, learning on: Identification of preference and challenges among school students towards distance learning during COVID-19 outbreak," *Int. J. Lifelong Educ.*, vol. 40, no. 1, pp. 53–71, 2021. https://doi.org/10.1080/02601370.2021.1874554

[47] P. Rivera-Vargas, T. Anderson, and C. A. Cano, "Exploring students' learning experience in online education: Analysis and improvement proposals based on the case of a Spanish open learning university," *Educ. Technol. Res. Dev.*, vol. 69, no. 6, pp. 3367–3389, 2021. https://doi.org/10.1007/s11423-021-10045-0

[48] E. Er, E. Gómez-Sánchez, Y. Dimitriadis, M. L. Bote-Lorenzo, J. I. Asensio-Pérez, and S. Álvarez-Álvarez, "Aligning learning design and learning analytics through instructor involvement: A MOOC case study," *Interact. Learn. Environ.*, vol. 27, nos. 5–6, pp. 685–698, 2019. https://doi.org/10.1080/10494820.2019.1610455

[49] C. Stewart and M. Bower, "Novice online educator conceptual frameworks: A mental model exploration of mindful learning design," *Educ. Media Int.*, vol. 56, no. 1, pp. 14–43, 2019. https://doi.org/10.1080/09523987.2019.1583463

[50] V. Singh and A. Thurman, "How many ways can we define online learning? A systematic literature review of definitions of online learning (1988–2018)," *Am. J. Distance Educ.*, vol. 33, no. 4, pp. 289–306, 2019. https://doi.org/10.1080/08923647.2019.1663082

[51] S. Adewale and M. B. Tahir, "Virtual learning environment factors as predictors of students' learning satisfaction during COVID-19 period in Nigeria," *Asian Assoc. Open Univ. J.*, vol. 17, no. 2, pp. 120–133, 2022. https://doi.org/10.1108/AAOUJ-10-2021-0121

[52] L. Pei and H. Wu, "Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis," *Med. Educ. Online*, vol. 24, no. 1, p. 1666538, 2019. https://doi.org/10.1080/10872981.2019.1666538

[53] R. A. Jastania *et al.*, "A qualitative study to improve the student learning experience," *Qual. Assur. Educ.*, vol. 25, no. 4, pp. 462–474, 2017. https://doi.org/10.1108/QAE-06-2016-0031

8 AUTHORS

Muhamad Arif Mahdiannur is an Assistant Professor at the Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. He earned his formal education from the Universitas Mulawarman, Indonesia, and the Universitas Negeri Surabaya, Indonesia. His formal education is focused on science and physics education. His research interests include design-based research in science education and teacher professional development. He is also a member of the Indonesian Society for Science Educators (PPII) and the Physical Society of Indonesia (PSI) (E-mail: muhamadmahdiannur@unesa.ac.id).

Martini is an Associate Professor at the Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. She earned her formal education from the IKIP Surabaya and Universitas Negeri Surabaya, Indonesia. Her research interests include science education and science teacher content knowledge. She is also a member of the Indonesian Society for Science Educators (PPII) (E-mail: martini@unesa.ac.id).

Dyah Astriani is an Assistant Professor at the Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. She earned her formal education from the Universitas Negeri Surabaya, Indonesia, and Universitas Negeri Malang, Indonesia. Her research interests include teaching and learning in science education. She is also a member of the Indonesian Society for Science Educators (PPII) (E-mail: dyahastriani@unesa.ac.id).

Laily Rosdiana is an Assistant Professor at the Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. She earned her formal education from the Universitas Negeri Surabaya, Indonesia. Her research interests include science and physics education, especially on multi-representation in learning. She is also a member of the Indonesian Society for Science Educators (PPII) (E-mail: lailyrosdiana@unesa.ac.id).

An Nuril Maulida Fauziah is an Assistant Professor at the Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. She earned her formal education from the Universitas Negeri Malang, Indonesia, and the Universitas Sebelas Maret, Indonesia. Her research interests include science and physics education, especially on engineering design process in learning. She is also a member of the Indonesian Society for Science Educators (PPII) (E-mail: annurilfauziah@unesa.ac.id).