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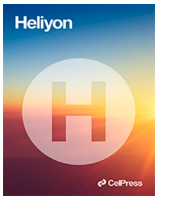

Research article

Examining pre-service teachers regulation in distance and traditional preschool design and technology education

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ABSTRACT

The significance of adapting to a rapidly changing world is quite evident in the current day; thus, the awareness of how to teach students so that they can be ready to face challenges in the future is very important. Early education has a huge impact on the further development of children, so preschool teachers must be competent and use appropriate teaching and educational methods. In this study, the development of self-directed learning (SDL) of future preschool teachers is investigated by considering two variables, namely the type of study (full-time and part-time students) and the learning modalities caused by the COVID-19 pandemic (pre-, during and post-COVID-19 confinement). We collected data from 418 participants and analysed them using descriptive statistics, 2 × 3 factorial analysis of variance (ANOVA) and a two-step cluster analysis. The results show the status of pre-service preschool teachers' perceptions of their SDL development and how the variables influenced it. There were significant differences in the students' self-reported SDL skills, depending on the learning environment and the type of study. The status indicator helps educators identify and change the curriculum and how they work with students. It allows the faculty to highlight the positive aspects of the different educational modalities encountered, as well as the characteristics of the study types and their impact on the learning process to improve students' SDL skills. The results of the study may help in the design of tailored metacognitive scaffolds that take into account different modalities. Further studies are needed to investigate the effectiveness of digital open learning environments that address both SDL and preschool educational practices.

1. Introduction

Education has undergone dramatic changes throughout its history. As a foundation of society's growth and one of the basic human rights, it is directly related to the realisation of other rights as well. Education represents the main driver of progress in sustainable development, as being one of the 17 Sustainable Development Goals [1]. Over time, the understanding of the learning process has evolved from mere memorisation of facts to larger dimensions [2]. Teachers and other educators aim to prepare students for life and future jobs, which will require well-developed 21st-century skills, such as critical thinking and problem-solving, creativity and innovation, communication, and others [3]. Besides the aforementioned learning and innovation skills, the process of 21st-century teaching and learning also requires knowing key subjects and 21st-century themes, information media and technology skills and

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life and career skills such as flexibility, productivity, leadership, responsibility, initiative, and self-direction [4].

Despite the advent of numerous strategies and the focus on various methodologies, knowledge transfer cannot be ignored when preparing students for the 21st century. Van Zyl and Mentz [5] summarise definitions of transfer provided by several authors as a continuous process with a strong link between student learning and response in individual situations, meaning that learning in one situation impacts problem-solving in another. Working on authentic, complex tasks requires students to set their own goals, find appropriate resources, and evaluate each task; therefore, such activities promote students' self-directed learning (SDL). At the same time, the above tasks may require an efficient transfer of knowledge to solve problems [5]. Moreover, when learners find the curricular content useful, they are more likely to transfer the knowledge they acquired and apply it in the future [6]. According to the Organisation for Economic Co-operation and Development (OECD), effective SDL requires learners to be proactive, be able to predict different outcomes and have their own assumptions while being able to consider other learners' ideas and expectations; moreover, critical thinking is required for learners to determine a goal and purpose for their learning [7]. In addition, the executive phase of SDL requires taking into account different perspectives so that new values can be created. The reflection phase of SDL creates a deeper understanding and allows for the continuity of learning. It includes motivation, behavioural and social components, creative thinking skills and self-directed skills [7]. This means that students must be able to organise their schedules well, search for relevant information, cope with problems, transfer knowledge to other contexts, apply different learning strategies, etc. [2].

Nowadays, great importance is attached to learning how to learn. It is the basis for lifelong learning, which is increasingly demanded and emphasised in today's world. According to Tekkol and Demirel [2], most researchers see a connection between self-direction and lifelong learning, so it could be said that these two concepts are interdependent and are the foundation for each other [2,8]. Learners' self-direction is demonstrated by setting goals that can be measured in both tangible and intangible ways, balancing short-term and long-term goals and time, planning well and completing work efficiently. In addition to managing goals and time, working independently also plays an important role in achieving learning outcomes. This includes taking the initiative to acquire expertise, expand one's learning, critically reflect on past events that impact the future, commit to learning as a lifelong process, etc. [3].

The SDL is a learning process in which the learner takes the initiative and has control over the entire learning process - readiness to learn, setting learning goals, engagement in active learning, and evaluation [9,10]. SDL can be perceived as a basic human competence - learning on one's own. Having control over one's learning also means taking responsibility for the learning outcomes [9,10]. According to different authors [11–13], SDL and student learning outcomes correlate. In addition, Okwuduba et al. [13] made the rather revealing finding that students' emotional intelligence significantly moderated the effect of self-directed learning. Furthermore, Lasfeto and Ulfa [14] find the relationship between educational modality and learning success, with online learning contributing to approximately 50% of learning success. For learning success, it is necessary to aim for a higher SDL level and to consider the potential influence of the different learning environments. SDL has attracted the attention of various researchers with different perspectives and fields [2,10,14–17]. Design and technology education (DTE) requires qualified people to do highly dynamic work. Preschool teachers must design and plan appropriate activities, select (the right) materials for the work, process them properly, etc. Due to the nature of the work and domain of DTE, preschool technical education requires a high level of SDL, particularly from a social and transformational point of view [15].

Self-direction and self-regulation are not important only for future educators but also for all learners, starting with the youngest. Some authors have succeeded in finding positive relationships between the promotion of self-regulated learning (SRL) competencies in young learners and successful coping with school challenges [18]. Moreira, Ferreira and Viega Simão [19] presented in their study the development and validation of a method for Dynamic Assessment of Self-regulated learning in Preschool (DASP). They also found that the multidisciplinary approach used in daily work and kindergarten practise can be the right and most effective way to introduce young children to strategies and practises of self-regulated learning [19]. The child's formation and improvement of the skills needed for everyday preschool activities are influenced by the interactions between the child and the educator. Children can use mentor feedback during activities to develop SRL strategies, and educators can adapt the approach to children's individual learning needs [19].

In the COVID-19 confinement era, college students were considered the information and communications technology (ICT) generation, and the educators likely had great confidence in the students' ability to adapt, motivate and self-direct during online learning [20]. Zeybek [21] states that there may be a relationship between computational thinking using ICT and the dimensions of online self-regulated learning; however, he also points to the targeted use of ICT and educational tools, especially in achieving higher levels of SRL (awareness, learning strategies, learning activities, evaluation and interpersonal skills). He also notes that purely instrumental use of ICT is not effective as opposed to life-oriented, time-limited, targeted use of ICT [21].

Although the study of SDL in teacher education is not entirely unheard of, its role and significance in different learning modalities and enrolment contexts have received only limited research. In addition, most studies in this area have focused on the development of social competence in pre-service teachers while the perspectives of pre-service teachers and their status in education have not been adequately explored. Pre-service teachers who work part-time are already employed in kindergarten, and their daily work is more of a pedagogical practice in which they acquire the skills and competencies that they need for their current work and further career. On the other hand, they perceive ICT and pedagogical tools more from a humanistic point of view, while their full-time colleagues deal with them on an instrumental level. To address these gaps, this study aims to explore this perspective by balancing the transactional distance using different teaching/learning modalities and providing deeper insights into the articulation of both SDL and technology-enhanced learning that is relevant to the development of 21st-century skills. To this end, the Slovenian Research Agency is providing a grant to support this study as part of the project entitled "Developing the Twenty-first Century skills needed for sustainable development and quality education in the era of rapid technology-enhanced changes in the economic, social and natural environment". One of the

project outcomes is the contextual and conceptual design of a new ICT-enhanced curriculum for design and technology subject matter, which links and integrates operational objectives and standards both horizontally and vertically with other curriculum areas (e.g., movement, language, art, society, nature, mathematics, etc.) for preschool and early childhood education and practise.

2. Literature review

2.1. Regulation of learning in educational settings

2.1.1. Self-directed and self-regulated learning

SDL and SRL are similar concepts, which is also evident in the literature where several authors sometimes use the terms of the different concepts as synonyms [22]. Self-regulated learning is understood as a proactive process that involves important components of self-direction and self-belief that learners use to control and monitor their own learning process [23]. Both concepts refer to two dimensions, internal (personality) and external (process), both concepts require the active participation of the learner, metacognition, and internal motivation. Key phases of both concepts are: 1. Task definition, 2. Goal setting and planning, 3. Selection and implementation of a strategy, and 4. Monitoring and reflection. The differences can be seen in the size of the constructs: SDL is considered a macro construct of which SRL is a part as a micro construct. The latter means that to develop SDL, mastery of SRL is primarily required. Furthermore, SDL is usually practised outside the traditional school environment, while SRL occurs within it. SRL focuses more on the learning process in the context of a specific, well-defined task, whereas SDL is understood as a learning approach in the learner's domain. Finally, in SDL the task is set by the learner, whereas in SRL this is often the responsibility of the teacher. This includes strengthening motivation, self-control, and belief in self-efficacy. For this reason, effective SDL is also effective SRL, which is not necessarily the case, the other way around [22,24].

As mentioned earlier, SDL requires motivation, which is one of the basic concepts of self-determination theory (SDT). SDT deals with human development, motivation, and well-being. Also, it deals with various problems such as self-regulation, psychological needs, influences on motivation, self-confidence, life goals, and behaviour … [25]. To achieve psychological well-being, competence (effectiveness in each situation), relatedness (interaction and feeling connected to the group) and autonomy (urge to control one's own life) must be fulfilled [26]. For successful self-determined behaviour, an individual must also possess several skills or abilities, such as problem-solving, decision-making, goal-setting, introspection, independence, risk-taking, self-awareness, leadership, etc. [27]. In addition, SDT suggests that learning environments should be structured in a way to support both motivation and learning [28]. On the other hand, Usher and Schunk [29] claim that students often need to rely more on extrinsic motivation-based regulation in their learning environments due to deadlines, social pressures, etc. Motivational constructs such as self-efficacy and attitudes toward goal achievement influence the choice of self-directed strategies, as noted by Mega et al., who highlight the relationship between motivational constructs and SDL. Furthermore, they confirm the connection between emotions, SDL, and motivation regarding academic success [30].

According to Alhazbi and Hasan [31], intrinsic motivation is an important factor influencing students' performance in online learning in a synchronous or asynchronous online environment, regardless of the student's level of SRL development. Motivation ensures the sustainability of effects and promotes students' creativity. The results also showed that there were no statistically significant differences in external motivation between more successful and less successful students in the online environment [31].

2.1.2. Importance of SDL in education and educational practice

SDL is an essential, primary skill/ability of learners preparing for 21st-century professions [2,32,33]. One of the earliest proponents of self-directed learning is Knowles, who described self-direction as a key element of adult learning. Also, SDL is considered an innate capacity of the learner [33,34].

Guglielmino and Guglielmino [35] address SDL as self-management learning. Modifying Knowels' definition of SDL, they refer to SDL as "a process in which the learner is responsible for identifying what is to be learned when it is to be learned, and how it is to be learned. The learner is also responsible for evaluating not only if the learning occurs, but if it is relevant to the objective" [35] (p. 37). Self-directed learners are typically curious, autonomous, and self-motivated. They are open to learning, and value it. This often leads them to take the initiative to learn, as they usually recognise the need to learn on their own. The learners set clear goals for themselves, design, monitor and control the entire learning process in accordance with these goals and finally evaluate it [2]. Learners plan and direct their learning, that is, they take responsibility for and are actively involved in the learning process [2,35].

According to Lasfeto and Ulfa [14], there is a correlation between students' SDL in an online environment and social interaction scores [14]. The crucial nature of the learning environment and teacher's relationship with students for SDL behaviour is also emphasised by Knowles [34]. He mentions creating a psychologically and physically comfortable, safe, and cooperative learning environment, open communication, and a close, friendly, and respectful relationship with learners is important for achieving positive outcomes [34].

According to Williamson [36], self-direction is the basis of both formal and informal learning. Everyone has the potential to develop self-direction, but the degree of development depends largely on individual characteristics. Also, the effectiveness of learning is highly influenced by the individual's motivation. Due to the importance of the concept of self-direction, researchers have developed instruments to measure the degree to which learners are self-directed. The data obtained not only will help teachers in their future work and adaptation to the learning environment but also the students who wants to know the concept (which may be less familiar to them) and pay more attention to it and its development [36].

2.1.3. Key aspects of SDL for effective learning

Because SDL encompasses the cognitive, metacognitive, behavioural, motivational and emotional aspects of learning, variables that influence learning must be carefully considered, given the differences in students' developmental or educational levels [37]. Variables that reflect different models of SDL may have a common denominator in awareness, learning activities, learning strategies, assessment skills and interpersonal skills, specifically individual-centeredness, interaction-centeredness and relationship-centeredness, as Pandero [37] explains.

Some authors define awareness as knowledge, namely knowledge of what is happening [38]. Awareness includes not only a state of knowledge (knowledge about time and space) but also dynamic processes (requires constant updating). It is through interactions with the environment that we maintain awareness [39]. The second dimension refers to learning strategies, which include focused procedures for memorising, remembering, understanding, etc., that we consciously employ. Learners decide not only the content of learning, but also the method itself, when, and where … They determine the learning resources and tools and choose an appropriate learning method. We distinguish metacognitive (includes organisation, attention, control …), cognitive (synthesis, analysis, reasoning, abstraction …), affective (motivation, experience of success) and social (interpersonal communication) learning strategies [40]. Learning strategies result in learning activities that represent the actual actions of the learner, such as the use of ICT, highlighting crucial information, using different learning methods and styles, etc. [41]. Another very important SDL dimension is evaluation, which is a process that humans constantly engage in. We evaluate ourselves, our environment, and our interactions with others from different perspectives. Evaluation is very important in education, where we determine the value of a certain educational activity based on certain criteria. There are several models of evaluation that Dočekal and Dvořáková [42] describe in their research. The phases are divided into the time before the activity (context and input), the time between and at the end of the activity (utility and affective reaction, acquisition of knowledge, skills, change of attitudes), and after the educational activity (job behaviour, organisational results, ultimate values) [42]. The critical skills in dealing with others are interpersonal. In education, these include empathy, control, student support, teacher motivation for students, etc. The complexity of the educational process requires teachers to have a great responsibility and a high level of teaching skills that majorly involve interpersonal skills. This leads to a high-quality relationship in the educational process, which is extremely important for quality education [43].

2.1.4. SDL in higher education

In their study, Watson et al. found that the levels of self-directed readiness among students in engineering programs did not significantly differ by class and year of study and that students' self-directed readiness improved among students during online distance learning during the COVID-19 pandemic [44].

Their paper also summarises the interesting findings of several other authors [45–48], who indicated that there were no significant differences in the degree of self-direction among students in different engineering majors and age groups. There were also no significant differences in the level of self-direction readiness of students who participated in e-learning modules compared to others who did not [44].

Liu et al. confirmed the summarised findings of many authors who found a relationship between 3D design and modelling courses and SDL, noting that SDL also strengthens 3D-design skills and promotes creativity and problem thinking. In addition, 3D-design lessons with SDL improve the learning outcomes and SDL skill development [45].

The use of metacognitive and social strategies in the context of SDL for computer-assisted learning is also mentioned by Pawlak in his study [46] that highlights the importance of learning strategies and self-regulation as two of the most important individual differences in language learning (second language learning and computer-assisted language learning). These findings might be helpful in the research of pre-service preschool teachers since they are aware of literacy development in preschool and early childhood education.

Bagheri et al. [32] concluded in their study that project-based learning has a positive effect on students' self-directed learning in higher education compared to conventional learning strategies. This is because the characteristics of activities in project-based learning require students to plan their time, be goal-oriented, responsible, self-assess, have control over their learning, etc., which correspond to the characteristics of self-direction. Project-based learning requires students to set a goal, actively participate, control and evaluate their work. For this reason, fostering and developing learners' self-direction is a logical consequence of the above-mentioned manner of working [32].

The results of another study [47], examining a convenience sample of female students from Saudi Arabia showed that the self-directed learning that students experienced during the sudden shift to distance learning had positive effects. One of the most important findings is that female students confirmed the use of SDL even after the end of the pandemic COVID-19. The female students demonstrated higher levels of independence, persistence, and engagement in learning through methods and approaches that involved self-directed learning during distance education. Alghamdi [47] noted that SDL contributed to students' educational growth during the distance learning crisis [47].

The urgent shift to online learning showed future teachers the rapidly changing situations of the present world. Students learned about online learning not only in theory but also through practice, and the effectiveness of learning depended on the learning environment and the individual's ability to self-regulate. The change in teaching methodology also changed students' perceptions of online learning [20]. In their study, Tarchi et al. [20] found that there were large differences in students' conceptualisation of online learning (which was to be expected given the different environments, the prevailing pedagogical approach, and the countries' technological support and preparedness). The transition to online learning was not gradual, social contacts were limited and were different in various countries, and social habits and different environments contributed to the differences in conducting online learning. An interesting finding of the study is that students did not associate the change in the learning environment with a change in pedagogical approach.

Students perceived online learning as learning without physical presence using technology. The ability to use ICT was most frequently cited by students as an SRL skill in online learning [20].

Avsec and Jagiełło-Kowalczyk [16] found in their study that architecture students felt responsible for their learning and recognised their learning needs well, connected knowledge with practice, used ICT effectively, etc. The results also showed the great possibility of using the design thinking method to develop students with a high level of intellectual development and achieve the goals of sustainable development [16]. This is also confirmed by Avsec and Ferk Savec [15] in another study, in which they stated that regardless of the good results in the development of students' SDL in both pedagogical and non-pedagogical fields of study, they still need help in ICT-supported learning for sustainable development [15]. In addition, SRL in an ICT-supported environment involves several challenges related to motivation, feedback, social connection, etc. [8].

In addition, Shafait et al. [48] study examined the effects of knowledge management processes on creative performance through the mediation of SDL in higher education. They found that emotional intelligence and the creation, acquisition, storage, sharing, and use of knowledge promoted SDL and had a statistically significant impact on it, which in turn increased the creative performance of academics in higher education [48].

The results of previous research, the importance of learning for sustainable development, and the relationship between SDL and online learning led us to believe that SDL is a variable of different learning environments [49].

2.2. ICT-enhanced teaching/learning

2.2.1. Emergency online distant learning due to COVID-19

In 2020, the COVID-19 pandemic impacted and altered education all over the world. In-person classes were replaced by online classes [50]. As a result of emergency online distance education, students faced even greater obstacles (logistical, academic, financial, cultural, and personal) to learning than usual [50].

During the pandemic confinement, many children were deprived of early education during the critical years of their development, as most did not receive a stimulating environment, sufficient socialisation, and in some cases adequate nutrition during this time [1, 50]. Hoofman and Secord [51], reported that families faced more stress [51]. Stress, isolation, constant sitting, etc. Led to mental and physical health problems (anxiety, depression, loneliness, sadness …) [50,51]. The consequences were observed throughout the education sector, all the way to higher education, where some subjects could not be taught due to a lack of digital infrastructure and digital technology literacy, and the inability to deliver certain content in online environments [1,52]. Masalimova [53] revealed that universities in the 21st century were unprepared for the digital learning environment presented by the COVID-19 situation, as evidenced by the insufficient use of digital platforms and the lack of digital skills among university pedagogical staff [53].

Khan et al. [54] reported that high costs of the Internet and data affected lecture attendance. Interestingly, there was a discrepancy in the perceptions of the effectiveness of online education in the study (faculty thought it was effective while the students did not). In their study, Ustun and Guler [55] confirmed that familiarity with useful Web 2.0 tools during undergraduate years is critical for future teachers and their subsequent use of such tools in the classroom. They found that by using Web 2.0 tools, students discarded their preconceptions, realised the benefits of using certain ICTs, and thus, increased the possibility of using those in their work. This is crucial in emergency situations and in times after a pandemic, as there is a possibility that some features of online distance education will remain in the future, which is also pointed out by Aladrović Slovaček and Matković [56], who suggest professional training for teachers. In addition, Khan et al. [54] mention a training proposal for students as well.

Many authors [56–59] state that one of the main problems of distance education in emergency situations lies with interaction and communication. On the one hand, Akachi and Ayed [59] as well as Yorkovsky and Levenberg [58] point out the importance of teaching certain areas (teaching entrepreneurship via authentic experiences, role-playing, workshops, etc. and teaching science and mathematics via experiments, demonstrations, etc.) in traditional ways. In Yorkovsky and Levenberg's [58] study, future teachers clearly prefer the traditional method to asynchronous online instruction (and the latter to synchronous online instruction). They also point to the problem of recording online lectures that make students feel uncomfortable, which may reduce their willingness to ask questions in case of any misunderstanding. Interaction, which is direct in a traditional way, is highlighted as an important factor in the study [58]. Moreover, Akachi and Ayed [59] emphasize the importance of learning as a social process and how reduced interaction lessens the effectiveness of learning. Aladrović Slovaček and Matković [56] also state that despite the attendance, students did not interact and collaborate in their learning. Lien [57] associates a reduction in interaction (disuse of web icons, refusal to use the camera and lack of interest in participating in question-and-answer activities) with less active participation in online lectures. Despite lower interest in participation, which also indicates lower autonomy, the study shows that students demonstrated some level of autonomy as they understood the lectures, met learning objectives and were able to search for learning materials, thereby indicating self-learning skills that are important for autonomy [57].

Furthermore, socioeconomic disparities among learners only widened the existing gap, creating new dimensions of disadvantage for these generations [1,28,50], as supported also in the Akaci and Ayed's [59] findings. Due to the difficult situation learners found themselves in during the COVID-19 pandemic, the focus shifted away from learning for many. Some learners felt more pressured to learn, which further hindered their ability to be self-directed and self-regulated [1,28].

While some students had psychological problems, a lack of social contacts, concentration difficulties, unsuitable learning environments, a lack of knowledge and skills in using ICT, an inability to adapt to new pedagogical methods, a lack of self-regulated learning, etc. [53,60]. Others reported that they felt safer at home during the pandemic and that they were able to save some money during COVID-19 confinement through online distance learning [53,61].

Learning in an online environment has already been studied by Elvers et al. [62] who pointed out the pitfalls of procrastination, so

for overcoming procrastination in the context of online learning, motivation is essential. Moreover, in the context of online learning, planning, monitoring, and evaluation are crucial for learning success state Song and Hill [49]. On the one hand, there are positive aspects of flexibility in a synchronous online environment [49,56]; on the other hand, the challenges that students face such as taking responsibility, making decisions about understanding the learning material, receiving feedback, etc. [49].

Yang [52] also finds positive aspects of this period that are manifested in the more frequent online communication between students and professors. Sobral et al. [60] report that there had been no significant differences between the internal and external motivation of students during that time [60]. Students' experiences with the use of computers and the internet were very positive; however, they wished to return to face-to-face teaching and learning [53,60]. In their study, Wagiran et al. [63] demonstrated that technological capabilities, equipment capabilities, user satisfaction and motivation had an impact on e-learning readiness during the COVID-19 pandemic times. However, before implementing e-learning, it is necessary to strengthen students' digital skills and at the same time, improve satisfaction with using online learning services to increase student motivation and readiness for e-learning [63]. In their study, Shehab et al. [64] conclude that students and staff at a university that is characterised by good ICT support and is familiar with the use of ICT equipment recommend the use of a hybrid learning model (combination of traditional and online learning) [64].

Despite its disadvantages, online learning offers students more flexibility and control over their learning in terms of pace and location of study, which was also considered an advantage in Çamlıbel-Acar and Eveyik-Aydın's [61] study. Online learning is challenging as it depends on several aspects: the type of communication, interaction, online environment, etc. Moreover, online learning requires proactivity, self-regulation, self-direction and the use of metacognitive skills in the key processes of one's learning—planning, implementation and evaluation [65].

2.2.2. Preschool design and technology teacher education

Early childhood has gained much attention in the current day society. It compensates for the differences in children's cognitive abilities before the young learners enter elementary school. Intensive development of cognitive skills also begins in early childhood; therefore, this period has a great impact on human development in later years. High-quality early childhood education thus has a positive impact on the development of language, mathematical thinking skills and children's behaviour [66]. In early education, children experience technical concepts and engineering thinking through play, in everyday situations, and even through problems they encounter. The latter has an enormously positive effect on the development of higher-order thinking skills, but children are at a disadvantage in certain situations due to overlooked opportunities and inadequate encouragement from the adults [67]. Integrating engineering thinking and design into preschool education allows children to engage with a wide range of STEM content. In this way, children learn about the entire process of engineering research, which includes finding a problem, imagining, and planning, and creating and improving on examples of real-world problem [68].

The so-called "engineering habits of mind" are described in detail by National Academy of Engineering and National Research Council [69]. The concept of "engineering habits of mind" encompasses thinking skills, attitudes and values associated with engineering and includes some of the 21st-century skills that children are expected to develop in order to function and succeed in a technology-driven and rapidly changing society [6]. Lippard et al. [67] indicate that the practice of teaching, while mandatory, is not necessarily sufficient to foster and develop engineering habits of mind in preschool education. In addition, professional development can improve teachers' confidence and ability to support early childhood engineering. Through the interaction between the use of engineering habits of mind, preschool teachers can improve not only these but also science and math constructs, as well as communication and literacy skills [67].

3. Objectives, hypotheses and research questions of the study

The principal objective of this study is to investigate how the effect of students' enrolment on SDL will depend on an educational modality. Thus, this study aims to contrast the following research hypotheses (H).

H1. There are significant differences in the levels of SDL among pre-service preschool teachers, generally due to different educational modalities imposed by the university during the COVID-19 pandemic.

H2. Different educational modalities will moderate the effect of student enrolment on SDL across its dimensions.

H3. SDL profiles in pre-service teachers discerned during COVID-19 confinement online learning will differ against the profiles before and after COVID-19 confinement.

The research questions (RQs) investigated are the following.

RQ1. Are there differences in self-assessed SDL ability as perceived by prospective preschool teachers participating in various university-mandated training modalities during the COVID -19 pandemic?

RQ2. To what extent is student enrolment related to SDL across its dimensions and is this relation moderated by different educational modalities?

RQ3. Which SDL profiles in pre-service preschool teachers can be discerned during COVID-19 confinement online learning?

4. Materials and methods

4.1. Research design

In this empirical cross-sectional study with quantitative approach, stratified random sampling method was used to select the target sample. The research design, including the variables, methods, and the study year in which the study was conducted, is presented in Table 1. The endogenous variable used in the study was perceived SDL level, while the exogenous variables were type of enrolment and educational modality.

4.2. Sample

The target sample was all second-year and third-year pre-service preschool teachers at the University of Ljubljana in the last four academic years since 2018/19 and those who attended the subject Technical Education. Initially, a sample of 865 participants was used. The sample size was then calculated by strata according to the type of student enrollment (full-time and part-time) and the period of study when being surveyed (pre-COVID-19 face-to-face learning, during COVID-19 confinement online distance learning, post-COVID-19 confinement face-to-face learning). A power analysis using GPower software [70] indicated that a total sample of 251 participants would be required to detect moderate effects for the *F*-test using the factorial ANOVA with two degrees of freedom and three groups. The final samplewas a total of 418 pre-service preschool teachers with an average age of 22.21 years ($SD = 5.03$). We excluded candidates who did not complete the entire questionnaire ($n = 27$) and those who failed at attention check items ($n = 18$). The response rate for the online tests we conducted was 48.3%, further supporting the findings of Wu et al. [71]. This sample size is considered appropriate and representative of the sample studied; it is also representative of the different types of the student's enrolment and period of being studied given that, in all cases, the sample size is greater than the minimum indicated by the statistical program (Table 2).

4.3. Design and technology structure and format in preschool teacher education at the University of Ljubljana

The participants were engaged in the Technical Education course conducted in the 2nd year of the Preschool Education study program. The characteristics of the course for full-time and part-time students can be found in Table 3. Regardless of the difference in the number of hours, the course examination is the same for students of both types of study enrolment.

The intended Technical Education course outcomes are knowing the materials, manufacturing processes, and the safe use of work equipment. Students are expected to integrate design and technology into kindergarten work in various areas of the educational process of the subject. The goal of the course at the reflective level also includes the students being aware of the importance of creative transformation and the processing of various materials for child development. In addition, students with their self-engagement are expected to develop creativity, responsibility for children's safety work, and critical thinking skills. An outline of the course content, objectives, and competencies is provided in Table 4 [73].

Course performance from the academic year 2018/19 through the academic year 2021/22 can be seen in Table 5. Students in traditional learning environments conducted lectures and practical work at the faculty. Full-time students performed in groups at a public kindergarten that collaborates with the faculty. They also observed their peers and gave feedback. Part-time students, on the other hand performed individually, usually in the kindergartens, where they were also (full-time) employed during their studies.

Students in a distance learning environment experienced adjustment in the delivery of the course. The content of the lectures was the same, only they took place in an online environment (no physical contact), however practical work was highly adapted to the online environment. The content and the products they produced were adapted, nevertheless comparable to the face-to-face learning environment. Prior to the performance, students received materials so that they could participate and make the products at home with the teaching assistant's online instructions. The content was adapted not only to the materials but also to the basic accessories (rarely tools) that the students were expected to possess at home. The performance in the kindergarten obligations was reduced only to the lesson plan.

The minimum score required for entry into the Preschool Education program at the Faculty of Education, the University of

Table 1
Research design of the study.

Research question (Hypothesis)	Academic Year	Method	Enrolment	Educational Modality	Depended variable
RQ1(H1), RQ2(H2), RQ3(H3)	2018/2019	Survey, inductive and deductive reasoning, literature review	Full-time Part-time	Pre-COVID-19 face-to-face learning	Self-reported measure of the SDL: Awareness, Learning activities, Learning strategies, Evaluation, Interpersonal skills
	2019/2020	Survey, inductive and deductive reasoning, literature review	Full-time Part-time	During COVID-19 confinement online distance learning	
	2020/2021	Survey, inductive and deductive reasoning, literature review	Full-time Part-time		
	2021/2022	Survey, inductive and deductive reasoning, literature review	Full-time Part-time	Post-COVID-19 confinement face-to-face learning	

Table 2
Research sample size with frequencies and (%).

Sex		Enrolment		Educational modality		
Male	Female	Full-time	Part-time	Pre-COVID-19 face-to-face learning	During COVID-19 confinement online distance learning	Post-COVID-19 confinement face-to-face learning
14 (3.3)	404 (96.7)	225 (53.8)	193 (46.2)	180 (43.1)	136 (32.5)	102 (24.4)

The sample was predominantly female, which is typical for samples enrolled in preschool or early childhood education and research [72].

Table 3
Technical Education course characteristics for full-time and part-time students.

	Full-time students	Part-time students
ECTS (European Credit Transfer System)	4	4
Semester	Winter/fall	Spring/summer
Lectures (hours)	15	10
Practical work (hours)	30	10
Other work[a] (hours)	16	5
Individual work[b] (hours)	59	95

[a] Carried out in the form of group performances in kindergarten and integrated teaching practice (including individual preparation, consultation with teaching assistant).
[b] Regular study, writing reports, regular assignments, exam preparation and other and other student work related to the course.

Table 4
Outline of the content, objectives, and competencies of the Technical Education course for preschool education students at the Faculty of Education, University of Ljubljana [73].

	Content (Syllabus outline)	**Objectives and competences**
Technical Education Curriculum	Introduction to design and technology through play	Teamwork, pair work, communication
	Toy diversity (different drives, materials, key components …)	Recognizing and considering children's individual needs
	Technical puzzles (construction, arrangement …)	Promotion of child's curiosity
	Work habits, skills, and knowledge development	Flexible organisation
	Creative technical educational activities for children	Interdisciplinary linking
	Manufacturing process (transformation techniques for paper, clay, wood, and soft metal …)	Knowing the content of design and technology
	Safety work (machines, tools, devices …)	
	Collecting various materials and ecological aspects	

Ljubljana from 2018 to 2021 is listed in Table 6. In each academic year, 55 positions were offered to full-time students and 60 to part-time students.

4.4. Measures

4.4.1. Demographics

Demographic information include age, sex, type of study enrolment and period of the study (educational modality). The type of study enrolment was measured by choosing one of two items: (1) full-time, and (2) part-time status, while the periods of the study were available as pre-COVID-19 period, during COVID-19 Confinement, and post-COVID-19 Confinement.

4.4.2. Self-directed learning

The COVID-19 pandemic affected education systems across the world and compared to the past, learning in forced circumstances has been very challenging, even for the brightest and most motivated students. Thus, self-directed learning gained importance and often it appeared as the only solution to cope with the challenges of the curriculum delivered at a distance online environment. Students must be aware of the real-world situation they faced and be ready to learn, able to set learning goals on their own, get engaged in the learning process, evaluate the learning they gained through and intentionally or unintentionally fine-tune their verbal and nonverbal behaviours to accommodate each other [74]. Moreover, students in an emergency or under forced learning as witnessed during COVID-19 Confinement, need to establish an emotional link with other people in a social environment and with peers and professors at the university, which can influence their relationships, experiences, and task/work involvement [75].

However, considering the above characteristics of self-directed learning and the fact that self-reported outcome assessment instruments are frequently used in the teacher education literature, Williamson's self-rating scale of self-directed learning seemed most

Table 5
The course performance due to the COVID-19 confinement and the use of ICT (L – lectures, PW – practical work, PK – performance in the kindergarten, T – traditional, D – distance, MsT – Microsoft Teams, online environment).

	Full-time students		Part-time students	
	Course performance	*Use of ICT*	*Course performance*	*Use of ICT*
Study year	T	Lecture presentation, quizzes	T	Lecture presentation, quizzes
2018/2019	T	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports	T	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports
	T	Writing a lesson plan, providing feedback on colleague's PK	T	Writing a lesson plan
Study year	T	Lecture presentation, quizzes	D	Lecture presentation, quizzes
2019/2020	T	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports	D	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports
	T	Writing a lesson plan, providing feedback on colleague's PK	D	Writing a lesson plan
Study year	D	MsT, lecture presentation, quizzes	D	MsT, lecture presentation, quizzes
2020/2021[a]	D	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports	D	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports
	D	MsT, presenting a lesson plan, writing a lesson plan	T	Writing a lesson plan
Study year	T	Lecture presentation, quizzes, MsT[c]	D	MsT, lecture presentation, quizzes
2021/2022[b]	T	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports, MsT[c]	T	Lesson presentation, quizzes, 3D-modeling, 3D-printing, technical reports
	T	Writing a lesson plan, providing feedback on colleague's PK	T	Writing a lesson plan

[a] Students have already experienced COVID-19 confinement in the 2nd semester of their 1st year of study.
[b] Students have already experienced COVID-19 confinement at the end of their graduation year and their 1st year of studying at university.
[c] Lectures and practical work were held in an online environment in case of infection with COVID-19 (approx. 25%).

Table 6
The minimum score required for entry into the Preschool Education program at the Faculty of Education from 2018 to 2021. Next to the minimum score recorded, the following is indicated in round brackets: (number of enrolled students/numbers of tendered places in the program).

Study year	Type of study enrolment	1st application deadline		2nd application deadline	
		1st wish	2nd and 3rd wish	1st wish	2nd and 3rd wish
2018/2019	Full-time	80 (55/55)	/	/	/
	Part-time	No point limit	57 (60/60)	77 (6/6)	/
2019/2020	Full-time	91,8 (55/55)	/	/	/
	Part-time	67 (60/60)	/	83 (7/7)	/
2020/2021	Full-time	90 (57/55)	/	/	/
	Part-time	No point limit	70 (60/60)	68 (8/8)	/
2021/2022	Full-time	90 (55/55)	/	/	/
	Part-time	No point limit	76 (60/60)	63 (17/16)	/

appropriate to detect the skills required for pre-service preschool teachers [15,36,41]. Despite that, we are aware that measurement criteria are not fixed attributes but are dependent on the context and population or the sample being studied, and if the questionnaire has not been validated in the sample of interest, it may be subject to measurement error. Also, any conclusions drawn cannot be made with total confidence as argued by Dowrick et al. [76].

This study used Williamson's self-directed learning questionnaire with a 5-point Likert scale, where the scale features 60 items in five subscales with 12 items each: awareness, learning strategies, learning activities, evaluation, and interpersonal skills (Annex 1).

4.5. Procedure and data analysis

The pre-service preschool teachers were informed about the study at the end of the training session. All necessary instructions were given on site or online. Only the students who completed all aspects of data collection were included in this study. The requirements for participation in the survey were aligned with the requirements for the final exam on the subject. Students who had chosen to major in design and technology needed to complete all assignments and tasks in order to take the final exam. Students who successfully prepared and submitted written documentation of products and exercises, who successfully worked in a kindergarten with a written assessment and who are enrolled in the academic year are eligible to take the final exam. Students in the Design and Technology subject must actively participate in at least 80% of the lectures and complete all laboratory assignments, regardless of which teaching/learning modality they have chosen or were enrolled in. In accordance with the guidelines of the General Code of Ethics of the University of Ljubljana, active informed consent was obtained from all students who participated in the study [77].

As this was a voluntary activity, students were free to withdraw from the study at any time, and there was neither an incentive to participate nor a penalty for not participating. A questionnaire was sent to prospective faculty email addresses in the form of a link

and/or quick response code (QR) and was also visible on the screen in the lecture hall (face-to-face mode) or on the screen of the MS Teams platform during the last session with the students (remote mode). Students participated in the study during face-to-face or online distance learning sessions at the end of the semester in January 2019, 2020, 2021, and 2022 (full-time students) and in May 2019, 2020, 2021, and 2022 (part-time students) throughout a study day. The online questionnaire was posted on the 1 KA portal (https://1ka.arnes.si/), and students completed the task in 12–13 min on average.The data were analysed using SPSS Statistics (v.25). The McDonalds Omega coefficient (ω) was used as a measure of the reliability of the responses collected in the one-time study, which provides a better estimate when ordinal data were collected [78,79].

The McDonalds Omega coefficient (ω) was computed with the macro OMEGA [79]downloaded from www.afhayes.com (accessed on July 27, 2022).

A descriptive statistics was used to describe the basic features of the data collected in this study.

For a nuanced investigation into whether some of the educational modalities would moderate the relationship between the type of enrolment of pre-service preschool teachers' and their self-directed learning, overall trends were examined. After reviewing these mean trends, we conducted a 2 × 3 factorial analysis of variance (ANOVA), which included condition and educational modality as independent variables and self-directed learning subscales as the dependent variable.

The clustering method was applied to reveal the profiles of self-directed learning using hierarchical cluster analysis, and k-means cluster analysis was performed to verify the clustering [80]. As a final, cross-tabulation with adjusted residuals was used to quantitively analyse categorical data of the relationship between cluster number of cases and educational modality and cluster number of cases and type of students' enrolment in the study.

4.6. Ethical consideration

This study was guided by a set of ethical principles for research. Scientific integrity, human rights, and human dignity were observed and aligned with the University of Ljubljana's General Data Protection Regulation (GDPR) [77]. Ethical approval for the study was obtained from the Head of the Department of Physics and Technology at the Faculty of Education, University of Ljubljana.

5. Results

5.1. Reliability and validity analysis

Prior to conducting further analyses, data were cleaned and coded, and each subscale was tested for internal consistency. We calculated the reliability of the self-directed learning subscales using the McDonald's omega and all subscales demonstrated sufficient internal consistency for basic research with scores of omega (ω) above 0.70 [81]. Means (*M*), standard deviations (*SD*), and bivariate Pearson's *r* correlation coefficient values between variables as an estimate of validity [82] can be found in Table 7. All validity estimates are above the acceptable level i.e. 0.6 [83].

The analyses of the homogeneity and criterion validity of all items under each subscale were satisfactory, with significant Pearson *r* values above 0.25 in all cases, which is greater than the critical value of 0.12 for a 0.01 level of significance at a two-tailed test where the degree of freedom is 400 [82].

5.2. Descriptive analysis

Pre-service preschool teachers' self-reported average scores across the subscales of SDL and in total are shown in Table 8. The values for asymmetry (skewness) and kurtosis of the research constructs are in acceptable ranges, since no value is above 1 (skewness) or 2 (kurtosis) as limit values for the proof of normal distribution [84].

The average total score (mean *M*) obtained by the participants was 244.67 out of 300 with a standard deviation of $SD = 26.42$ and a range of 144–298. This represents a high level of SDL ability. Nineteen per cent of the sample obtained 221 points or less, while about 75% of the participants obtained 263 points or less. Stratifying the scores as suggested by Williamson [36] such that no participant was placed at the lowest level (60–140), while 76 (19%) of the participants were placed at the intermediate level (141–220), and the majority (342, 81%) were placed at the highest level. This indicates effective SDL. The goal is to maintain progress by identifying strengths and methods for the consolidation of the students' effective SDL [36].

Table 7
Reliability McDonald's ω and Pearson *r* coefficient of the self-directed learning questionnaire subscales and in total.

	Awareness	Learning strategies	Learning activities	Evaluation	Interpersonal skills	SDL total
McDonald's ω	0.801	0.837	0.808	0.868	0.857	0.953
Awareness	1	0.675[a]	0.612[a]	0.628[a]	0.632[a]	0.808[a]
Learning strategies		1	0.733[a]	0.672[a]	0.720[a]	0.883[a]
Learning activities			1	0.743[a]	0.684[a]	0.888[a]
Evaluation				1	0.658[a]	0.868[a]
Interpersonal skills					1	0.862[a]
SDL total						1

[a] Correlation is significant at the 0.01 level (2-tailed).

Table 8
Pre-service preschool teachers' self-reported average scores across the subscales of SDL and in total accompanied with a measure of skewness (*S*) and kurtosis (*K*) ($n = 418$).

SDL	*Min.*	*Max.*	*M*	*SD*	*S*	*K*
Awareness	31.00	60.00	50.58	5.09	−0.64	0.45
Learning strategies	27.00	60.00	48.66	6.17	−0.52	0.02
Learning activities	23.00	60.00	47.19	6.24	−0.59	0.63
Evaluation	20.00	60.00	48.23	6.73	−0.68	0.61
Interpersonal skills	20.00	60.00	50.00	6.39	−0.71	0.96
SDL total	144.00	298.00	244.67	26.42	−0.49	0.16

To find differences in SDL across subscales, we further stratified the sample across the period or educational modality. A descriptive analysis was conducted to observe the behaviour of the variables in the samples for the five subdimensions of SDL and the variable of educational modality. These analyses show that the self-reported averages differ in some items at each subscale across different educational modalities (Figs. 1–5). All survey items given are derived from the original questionnaire developed by Willamson [36] and are enclosed in quotation marks for better understanding of the figures.

A quick look at the charts (Fig. 1) shows that students scored the different items differently. Regardless of the educational modality, students rated items AW5 and AW6 slightly higher and items AW4 and AW7 slightly lower than the others (Appendix 1). There are no major deviations in the scores when only comparing the different educational modalities. However, we can notice the difference in item AW3: "I consider teachers as facilitators of learning rather than providing information only." A statistically significant difference is found between the group of students in post-COVID-19 confinement face-to-face learning who rated this item significantly higher than the students in pre-COVID-19 face-to-face learning. Item AW6: "I am responsible for identifying my areas of deficit," was rated statistically significantly higher by the group of students in pre-COVID-19 face-to-face learning than by those during the COVID-19 confinement online distance learning. Regarding item AW10: "I need to keep my learning routine separate from my other commitments," there are differences between groups in pre-COVID-19 face-to-face learning and post-COVID-19 confinement face-to-face learning, who rated the item statistically significantly higher than students during COVID-19 confinement online distance learning. Finally, a statistically significant difference is also observed for item AW12: "I feel that I am learning despite not being instructed by a lecturer", where students in post-COVID-19 confinement face-to-face learning rated this item statistically significantly higher than students in pre-COVID-19 face-to-face learning and during the COVID-19 confinement online distance learning.

Observing the students' learning strategies scores in charts (Fig. 2), it is evident that in all educational modalities the items LS6 and LS12 have a higher score than others, while LS1 and LS10 have lower scores, although the scores in general are all quite high.

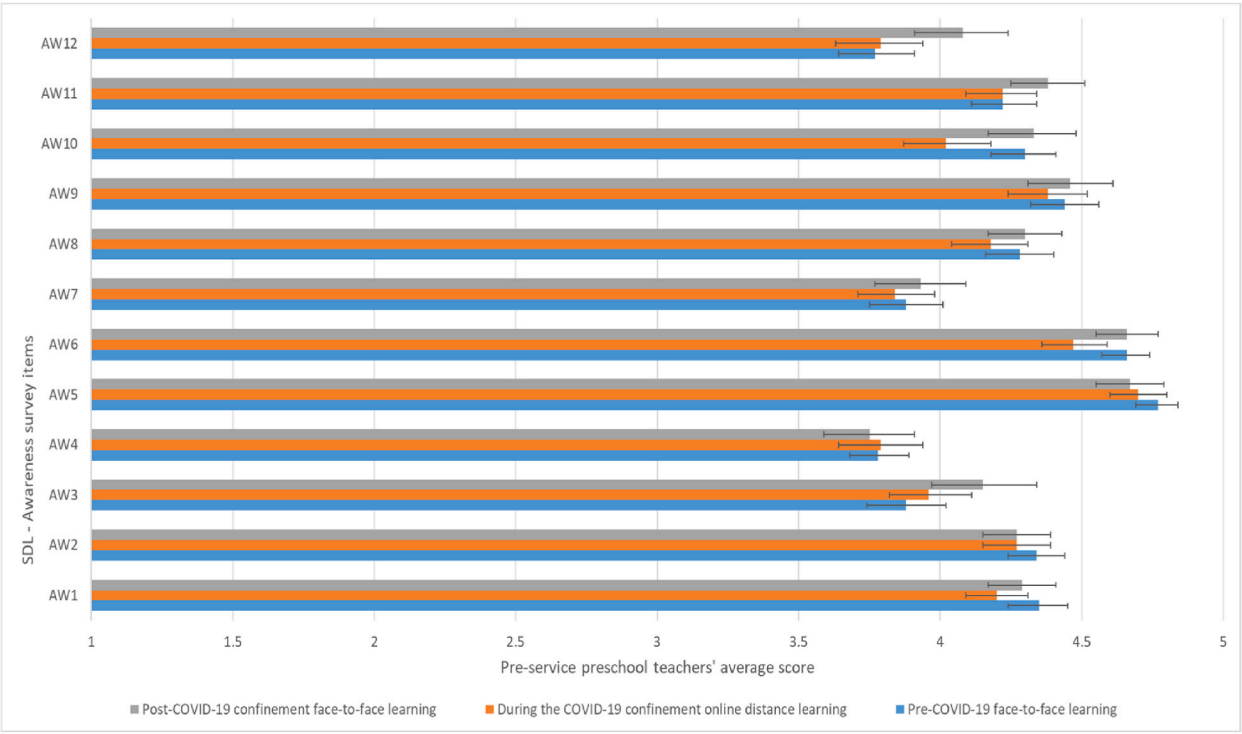

Fig. 1. Students' Awareness scores across educational modalities with 95% confidence intervals.

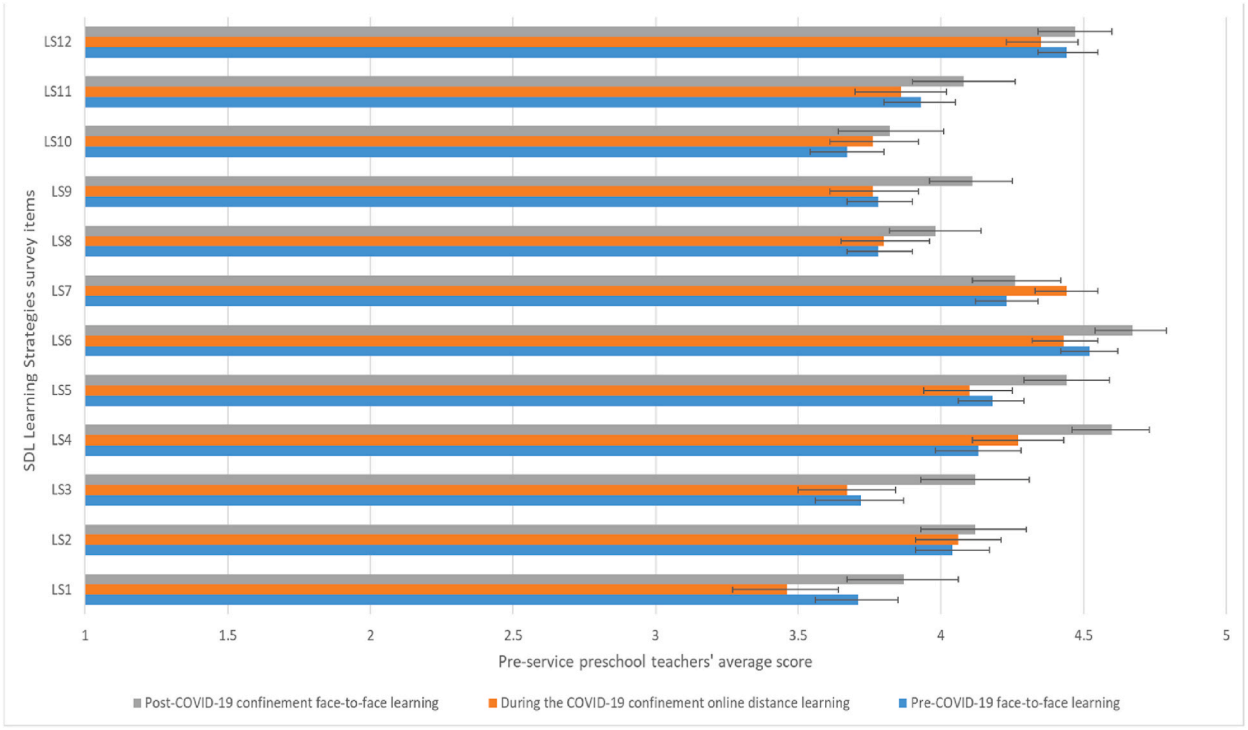

Fig. 2. Students' Learning strategies scores across educational modalities with 95% confidence intervals.

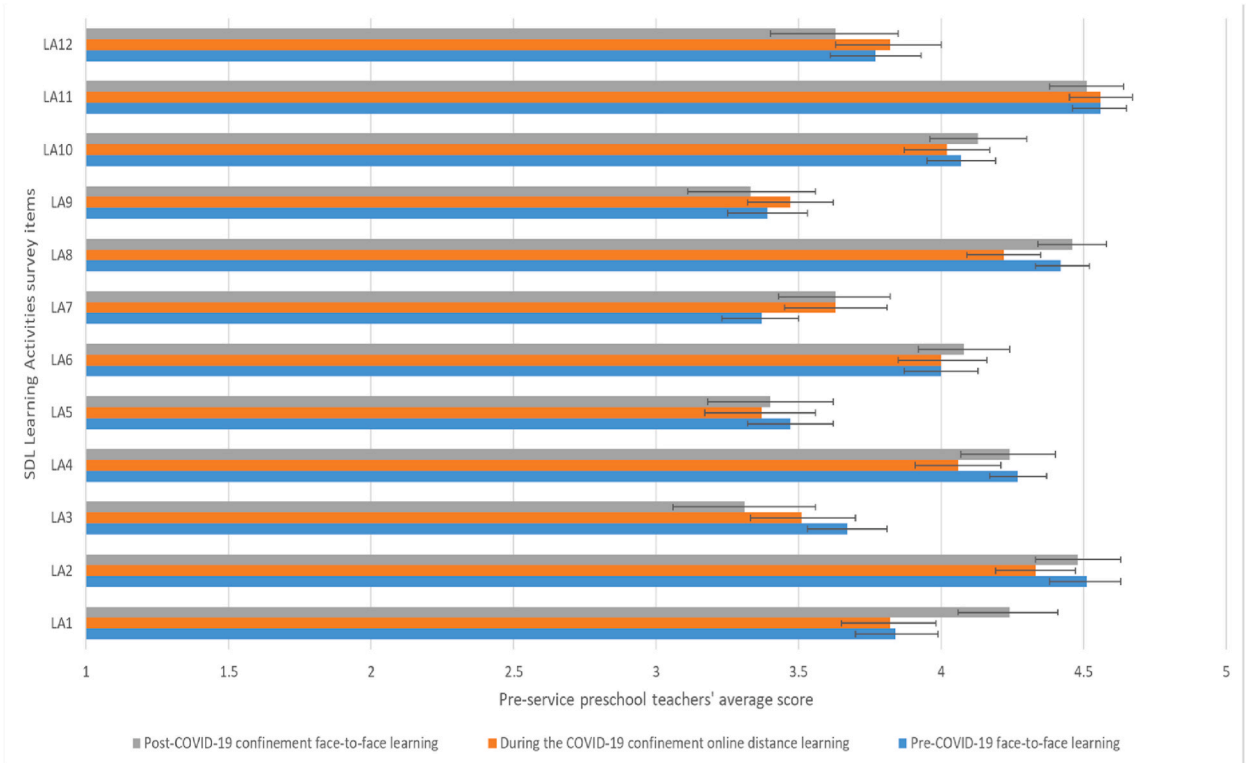

Fig. 3. Students' Learning activities scores across educational modalities with 95% confidence intervals.

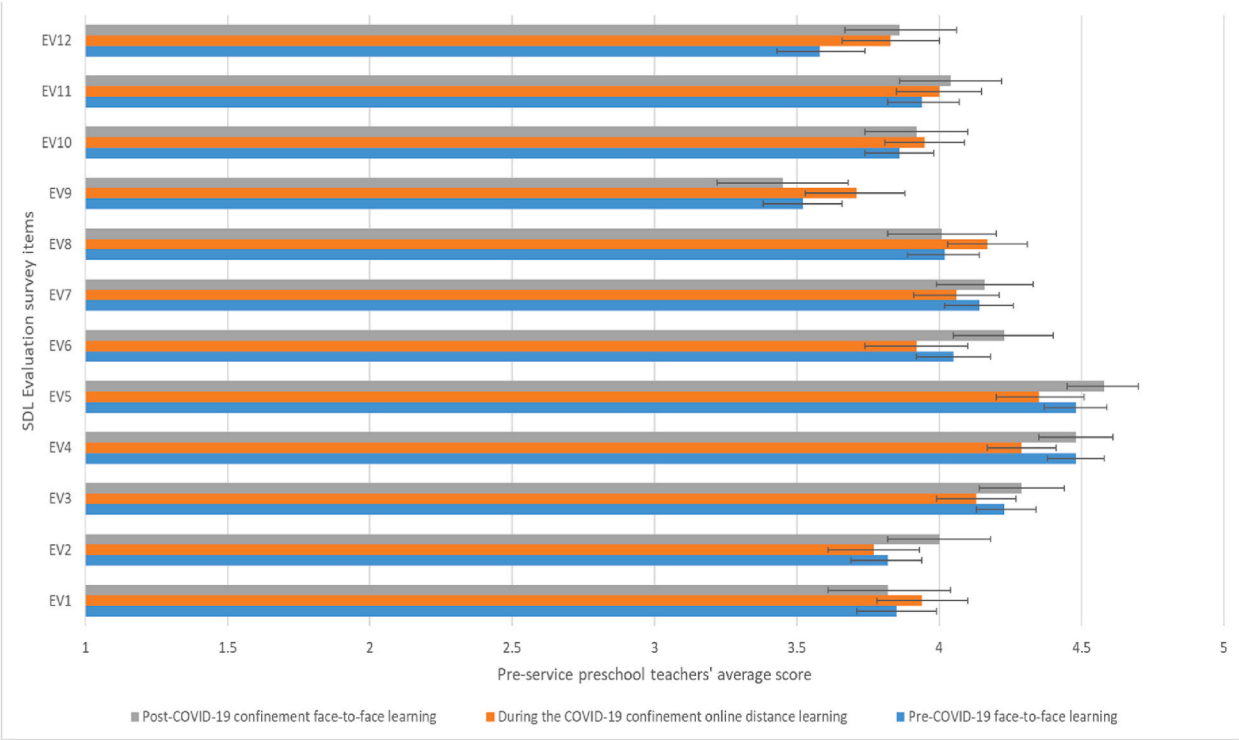

Fig. 4. Students' Evaluation scores across educational modalities with 95% confidence intervals.

Statistically, significant differences were found among items LS1, LS3, LS4, LS5, LS6, LS7, and LS9. The group of students in post-COVID-19 confinement face-to-face learning scored the items LS3: "I find 'role play' is a useful method for complex learning," LS4: "I find inter-active teaching-learning sessions more effective than just listening to lectures," LS5: "I find simulation in teaching-learning useful," LS9: "I arrange my self-learning routine in such a way that it helps develop a permanent learning culture in my life," significantly higher than students during COVID-19 confinement online distance learning and also students pre-COVID-19 face-to-face learning. Regarding items LS1: "I participate in group discussion," and LS6: "I find learning from case studies useful," students during COVID-19 confinement online distance learning scored statistically significantly lower than students in post-COVID-19 confinement face-to-face learning. Lastly, students in pre-COVID-19 face-to-face learning rated item LS7: "My inner drive directs me towards further development and improvement in my learning," statistically significantly lower than students during COVID-19 confinement online distance learning.

The chart in Fig. 3 shows the differences between students' perceptions of learning activities, which scored lower on several items than on other SDL constructs. There are statistically significant differences in the case of the item LA1: "I rehearse and revise new lessons," where students in post-COVID-19 confinement face-to-face learning scored statistically significantly higher than students during the COVID-19 confinement online distance learning and students in pre-COVID-19 face-to-face learning. Item LA3: "I use concept mapping/outlining as a useful method of comprehending a wide range of information," scored statistically significantly lower from students post-COVID-19 confinement online distance learning than students in pre-COVID-19 face-to-face learning. There is also a difference for item LA7: "I enjoy exploring information beyond the prescribed course objectives," since students in pre-COVID-19 face-to-face learning scored statistically significantly lower than students during the COVID-19 confinement online distance learning. Additionally, students during the COVID-19 confinement online distance learning scored item LA8: "1 a.m. able to relate knowledge with practice," statistically significantly lower than students in both other educational modalities.

A quick look at the graph in Fig. 4 shows that there are no significant differences in students' Evaluation scores. However, there are statistically significant differences between items EV4 and EV6. Students in pre-COVID-19 face-to-face learning rated item EV4: "I am able to identify my areas of strength and weakness," statistically significantly higher than students during the COVID-19 confinement online distance learning. In addition, these students rated EV6: "I find both success and failure inspire me to further learning" statistically significantly lower than students in post-COVID-19 confinement face-to-face learning.

The item IPS6 stands out in the chart in Fig. 5 as it scored higher than all the other items, regardless of different educational modalities. There are statistically significant differences in items IPS8, IPS10 and IPS12. IPS8: "I am successful in communicating verbally," scored higher by students in post-COVID-19 confinement face-to-face learning compared to the score by students during the COVID-19 confinement online distance learning. The same statistically significant differences occur in item IPS10: "I am able to express my ideas effectively in writing," adding that students during the COVID-19 confinement online distance learning scored statistically significantly lower also than students in pre-COVID-19 face-to-face learning. Lastly, item IPS12: "I find it challenging to

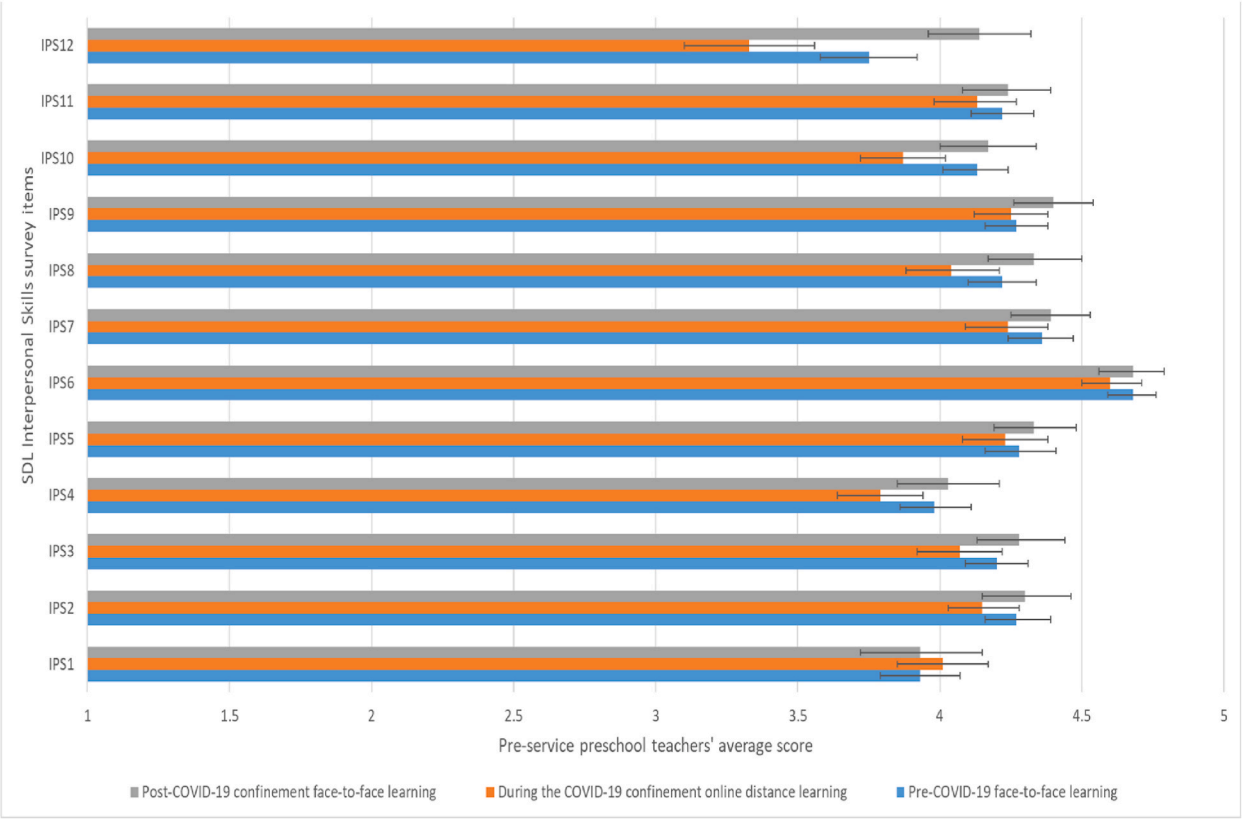

Fig. 5. Students' Interpersonal skills scores across educational modalities with 95% confidence intervals.

Table 9
Heat map of the significance and effect size[a] (η^2) of mean differences between the groups of students[b] regarding their ability for SDL across subscales significant items.

SDL subscale	Item	Group 1 vs Group 2		Group 2 vs Group 3		Group 1 vs Group 3	
		p-value	η^2	*p*-value	η^2	*p*-value	η^2
Awareness	AW3					0.040	0.01
	AW6	0.033	0.02				
	AW10	0.020	0.03	0.031	0.02		
	AW12			0.039	0.02	0.018	0.03
Learning strategies	LS1			0.005	0.03		
	LS3			0.002	0.04	0.004	0.04
	LS4			0.021	0.03	0.000	0.06
	LS5			0.004	0.03	0.027	0.02
	LS6			0.030	0.02		
	LS7	0.030	0.02				
	LS9			0.004	0.03	0.004	0.03
Learning activities	LA1			0.002	0.03	0.003	0.03
	LA3					0.024	0.02
	LA7	0.048	0.01				
	LA8	0.032	0.02	0.025	0.02		
Evaluation	EV4	0.046	0.01				
	EV6			0.039	0.01		
	IPS8			0.038	0.02		
Interpersonal skills	IPS10	0.019	0.03	0.019	0.03		
	IPS12	0.006	0.05	0.000	0.07	0.000	0.07

[a] η^2 as a measure of effect size is divided into small effect ($.01 \leq \eta^2 < .06$), medium effect ($.06 \leq \eta^2 < .14$) and large effect ($.14 \leq \eta^2$) [85].
[b] Group 1: Pre-COVID-19 face-to-face learning, Group 2: During COVID-19 confinement online distance learning, Group 3: Post-COVID-19 confinement face-to-face learning.

pursue learning in a culturally diverse milieu" scored statistically significant differences between students in all educational modalities. Students in post-COVID-19 confinement face-to-face learning scored higher than all other students. In addition, students in pre-COVID-19 face-to-face learning rated the item statistically significantly higher than students during the COVID-19 confinement online distance learning.

To find the differences between the groups of students regarding their ability for SDL across its subscales, a MANOVA test was used with Tukey post hoc tests when equal variances were assumed and the Games-Howell test when equal variances were not assumed. The Bonferroni correction was used to adjust the probability values because the risk of a type I error in multiple comparisons between educational modalities.

To better understand pre-service teachers' SDL in different educational modalities, all statistical information was processed graphically (Table 9) using a heat map, with significant differences in the aspects such as small effect size in yellow hues, the medium effect size in orange hues, representing statistical significance according to the *F* test.

As can be seen from the charts (Figs. 1–5), there were statistically significant differences in the items of certain SDL constructs between students in different educational modalities. Table 8 presents the statistically significant differences numerically. Furthermore, it is necessary to highlight the larger effect sizes of these differences. These occurred for item LS4 between Groups 1 and 3 and for IPS12 between Groups 2 and 3 and Groups 1 and 3. Thus, based on the content of the items, students perceived the effectiveness of interactive teaching and learning sessions compared to only listening to lectures in post-COVID-19 confinement face-to-face learning higher compared to the item being scored by students during the COVID-19 confinement online distance learning.

A larger difference in the perceptions emerged for item IPS12, since students in post-COVID-19 confinement face-to-face learning rated the item higher than students in pre-COVID-19 face-to-face learning and during the COVID-19 confinement online distance learning, regarding the difficulty of studying in a culturally diverse environment. Before and during the COVID-19 confinement, students were less likely to rate learning in a culturally diverse environment as challenging, while this perception changed and increased in post-COVID-19 confinement face-to-face learning.

The first hypothesis affirmed the existing differences in self-reported SDL among students who were taught design and technology through different educational modalities, before, during and after COVID-19 confinement.

5.3. Relationship between SDL, educational modalities, and students' enrolment

This study's second hypothesis predicted that educational modality would moderate the effect of students' enrolment on SDL.

Prior to conducting 2 × 3 factorial analysis of variance (ANOVA), pre-analysis investigations were conducted to check the normal distribution of data, homogeneity of variance, homoscedasticity, and the multicollinearity between students' educational modality and enrolment type as an independent variable and SDL dimensions as a dependent variable. No assumption was violated ($p > 0.05$).

Prior to testing the second hypothesis, overall trends were examined across all subscales of SDL.

As shown in Fig. 6, trends in all three educational modalities looked fairly similar. Self-reported awareness appeared to be slightly higher for full-time students, especially in pre-COVID-19 face-to-face learning.

After reviewing the mean trends, we conducted a 2 × 3 ANOVA, which included educational modality and condition as independent variables and awareness as the dependent variable (Table 10). Results indicated a significant main effect for type of enrolment, $F(1, 417) = 27.68$, $p = 0.000 < 0.05$, educational modality, $F(1, 417) = 3.45$, $p = 0.033 < 0.05$, and a significant interaction term, $F(2, 416) = 3.57$, $p = 0.029$ with medium to small effect size partial eta squared (0.063, 0.016, and 0.017; respectively).

The same procedure was also applied in other subscales of SDL, and fairly similar mean score trends were detected at all subscales, as we can see from Fig. 6. We also conducted factorial ANOVA for each dimension of SDL, and the results are shown in Tables 11–14.

5.4. Profiles of regulators during design and technology course subjected to different educational modalities and conditions

In view of testing the third hypothesis, a two-step cluster anylsis was conducted as a hybrid approach which first uses a distance measure to separate groups and then a probabilistic approach to choose the optimal subgroup model as proposed by Vermunt et al.

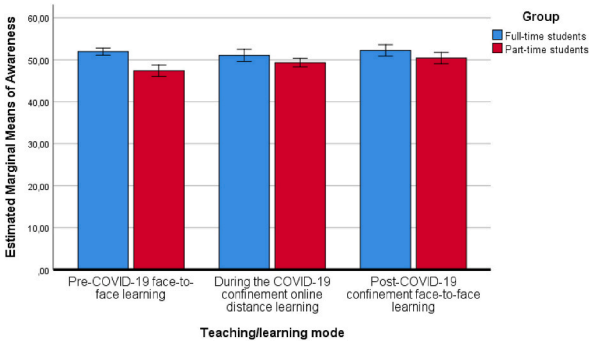

Fig. 6. The relationship between Awareness, educational modalities, and student enrolment.

Table 10
Awareness by educational modality and type of students' enrolment.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p-value*	*Partial Eta Squared*
Corrected model	1045.55	5	209.11	8.811	0.000	0.097
Intercept	906301.04	1	906301.04	38187.95	0.000	0.989
Enrolment	656.96	1	656.96	27.68	0.000	0.063
Educational modality	163.94	2	81.97	3.45	0.033	0.016
Enrolment x Educational modality	169.46	2	84.73	3.57	0.029	0.017
Error	9777.84	412	23.73			
Total	1080467.00	418				

Table 11
Learning strategies by educational modality and type of students' enrolment.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p-value*	*Partial Eta Squared*
Corrected model	1570.61	5	314.12	9.016	0.000	0.099
Intercept	845984.78	1	845984.78	24281.30	0.000	0.983
Enrolment	678.83	1	678.83	19.48	0.000	0.045
Educational modality	735.36	2	367.68	10.55	0.000	0.049
Enrolment x Educational modality	277.47	2	138.73	3.98	0.019	0.019
Error	14354.49	412	34.84			
Total	1005870.00	418				

Results indicated a significant main effect for type of enrolment, $F\,(1, 417) = 19.48$, $p = 0.000 < 0.05$, educational modality, $F\,(1, 417) = 10.55$, $p = 0.033 < 0.05$, and a significant interaction term, $F\,(2, 416) = 3.98$, $p = 0.019$ with medium to small effect size partial eta squared (0.045, 0.049, and 0.019; respectively).

Table 12
Learning activities by educational modality and type of students' enrolment.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p-value*	*Partial Eta Squared*
Corrected model	695.135	5	139.02	3.679	0.003	0.043
Intercept	791314.49	1	791314.49	20939.68	0.000	0.981
Enrolment	346.31	1	346.31	9.16	0.003	0.022
Educational modality	59.354	2	29.67	0.78	0.457	0.004
Enrolment x Educational modality	234.44	2	117.22	3.10	0.046	0.015
Error	15569.55	412	37.79			
Total	947162.00	418				

Results indicated a significant main effect for type of enrolment, $F\,(1, 417) = 9.16$, $p = 0.003 < 0.05$, and a significant interaction term, $F\,(2, 416) = 3.10$, $p = 0.046$ with small effect size partial eta squared (0.022, 0.015; respectively).

Table 13
Evaluation by educational modality and type of students' enrolment.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p-value*	*Partial Eta Squared*
Corrected model	471.05	5	94.21	2.10	0.064	0.025
Intercept	826791.82	1	826791.82	18494.88	0.000	0.978
Enrolment	187.66	1	187.66	4.19	0.041	0.010
Educational modality	169.50	2	84.75	1.89	0.151	0.009
Enrolment x Educational modality	175.12	2	87.56	1.95	0.142	0.009
Error	18417.97	412	44.70			
Total	991392.00	418				

Results indicated a significant main effect only for the type of enrolment, $F\,(1, 417) = 4.19$, $p = 0.041 < 0.05$ with small effect size partial eta squared (0.010).

[86]. In the first step, hierarchical cluster analysis was conducted to separate groups of students engaged in SDL. Cluster analysis reported a three-cluster classification as the optimal solution for the data considered in the present study. Based on the mean scores for students' SDL behaviour for each cluster, we discerned three regulation profiles (see Table 14). The first cluster, representing the minority of students ($n = 90$; 21.53%), revealed low mean scores on all SDL subscales. In the second cluster ($n = 189$; 45.31%), students' regulation behaviour is characterised by a larger involvement in regulation through awareness and interpersonal skills, while the third cluster ($n = 139$; 33.25%) represented students whose regulation behaviour is on a high level at all SDL dimensions, with higher developed interpersonal skills (Fig. 7).

To validate the three-cluster solution found in the hierarchical cluster analysis, a k-means cluster analysis was performed … Table 15 reveals that the final three-cluster solution was confirmed. A total of 19.14% of students could be profiled as low SDL, 43.30%

Table 14
Interpersonal skills by educational modality and type of students' enrolment.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p-value*	*Partial Eta Squared*
Corrected model	2387.28	5	477.45	13.38	0.000	0.140
Intercept	887605.78	1	887605.78	24891.15	0.000	0.984
Enrolment	1420.14	1	1420.14	39.82	0.000	0.088
Educational modality	341.45	2	170.72	4.78	0.009	0.023
Enrolment x Educational modality	345.49	2	172.74	4.84	0.008	0.023
Error	14691.71	412	35.65			
Total	1062179.00	418				

Results indicated a significant main effect for type of enrolment, $F\,(1, 417) = 39.82$, $p = 0.000 < 0.05$, educational modality, $F\,(1, 417) = 4.78$, $p = 0.009 < 0.05$, and a significant interaction term, $F\,(2, 416) = 4.84$, $p = 0.008$ with medium to small effect size partial eta squared (0.088, 0.023, and 0.023; respectively).

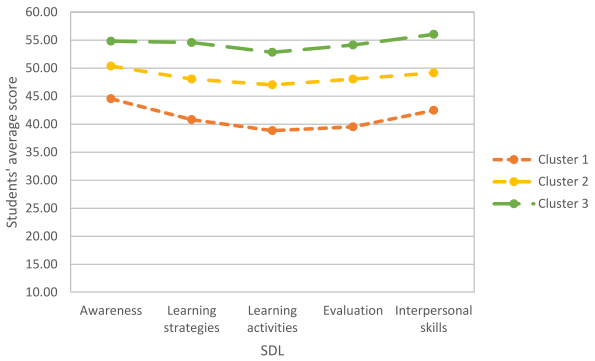

Fig. 7. Three-cluster solution of SDL presenting mean values to ease interpretation of clusters with respect to average sample scores per dimension.

Table 15
Mean scores (cluster centres) of the SDL profiles on the cluster variables.

	Hierarchical clustering			k-means clustering		
	1	2	3	1	2	3
Cluster variables	Low SDL (n = 90)	Medium SDL (n = 189)	High SDL (n = 139)	Low SDL (n = 80)	Medium SDL (n = 181)	High SDL (n = 157)
Awareness	44.53	50.36	54.81	44.33	49.88	54.59
Learning strategies	40.81	48.06	54.58	40.29	47.75	53.99
Learning activities	38.86	47.02	52.83	38.50	46.48	52.44
Evaluation	39.52	48.05	54.12	38.94	47.50	53.82
Interpersonal skills	42.47	49.15	56.04	42.10	48.59	55.66

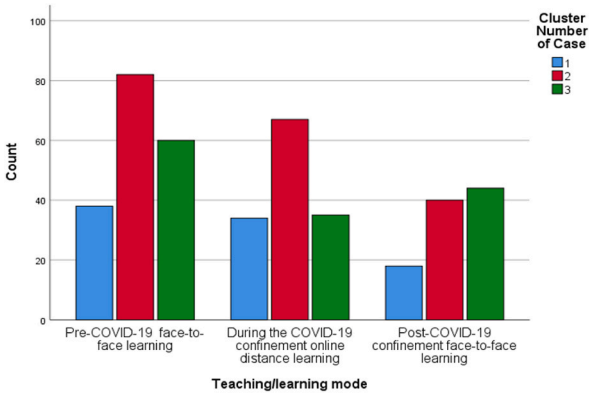

Fig. 8. Pre-service preschool teacher cluster membership according to the three educational modalities.

as medium SDL, and 37.56% as high SDL.

Further, we analyse how the SDL clusters as regulatory profiles are composed according to the type of enrolment and educational modality. An examination of SDL profiles on the three educational modalities in the last four years indicated different cluster membership distributions. When the *chi-square* tests were initially statistically significant, subsequent analyses used adjusted standardized residual values [87,88] to examine the contribution of each cell in the cross-tabulation to the *Chi-square* value.

Crosstab analysis indicated that there was no significant correlation between cluster membership and enrolment in different educational modalities (*Chi-square* = 8.10, $p = 0.088$, *Cramer's V* = 0.098). Students' distribution according to SDL profile (cluster) and educational modality is shown in Fig. 8.

An examination of SDL profiles on the two types of enrolment indicated different cluster membership distributions. Crosstab analysis indicated that there was a significant correlation between cluster membership and type enrolment (*Chi-square* = 21.41, $p = 0.000$, *Cramer's V* = 0.23). Students' distribution according to SDL profile (cluster) and enrolment type is shown in Fig. 9.

A crosstab between the type of students' enrolment in the course versus their cluster membership showed students who scored higher had been involved in the course as full-time students (adjusted standardised residual was 3.0) while pre-service preschool teachers with the lower ability for SDL are rather related with part-time enrolment type in cluster 1 (adjusted standardised residual was 4.4) (Table 16). To adjust for multiple non-independent testing, we adopted a conservative criterion of adjusted standardised residuals values $\geq \pm 3$ as suggested by Landis et al. [86].

It is noticeable that during the COVID-19 confinement, the column of cluster 2 is slightly larger, which means that in this period the majority of students assessed their SDL as belonging to the middle SDL group (Fig. 8). The results show that in the period during the COVID-19 confinement, a larger number of students from cluster 3 was anticipated and that in the post-COVID-19 face-to-face learning, cluster 3 was expected to be less represented, while it was slightly more represented. Otherwise, the differences are not significant, so we cannot conclude the observations with certainty.

The distribution of students by clusters according to the type of study (Fig. 9) shows that the majority of full-time students are found in clusters 2 and 3 (medium and high SDL); in contrast, there is a larger proportion of part-time students in clusters 2 and 1 (medium and low SDL).

6. Discussion

Educational changes in recent years have not only brought negative consequences but also positive effects, which are expected to be transferred to and implemented in the future [50]. Different self-regulation profiles can be shaped in students through various motivational strategies in learning environments [89]. According to Carter et al. [28], the importance of SDL was particularly evident during the COVID-19 pandemic and online distance education. Furthermore, some authors [17] state that online learning has positive effects on SDL development. Therefore, we investigated how different modalities of DTE (distance and traditional learning) affect SDL in pre-service preschool teachers, also mediated by two conditions (part-time and full-time students). This study provided very interesting results on how SDL can be shaped in different educational modalities in DTE. Students' SDL differs across its subscales, suggesting that some critical aspects of DT teaching and learning need to be modified. The differences between students in different learning environments and full-time and part-time studies and their mediating roles are also discussed. Our findings will be useful for DTE course designers, and educators to further enhance the development of self-regulation in students to optimize the efficiency of a student-centred active approach.

6.1. SDL ability among pre-service preschool teachers

Statistically significant differences emerged regarding the self-reported level of SDL among pre-service preschool teachers in our study. Significant differences were found for 7 of 12 items on the learning strategy dimension, for 4 of 12 items on the awareness and learning activities dimensions, for 3 of 12 items regarding interpersonal skills, and lastly only 2 of 12 items on the evaluation

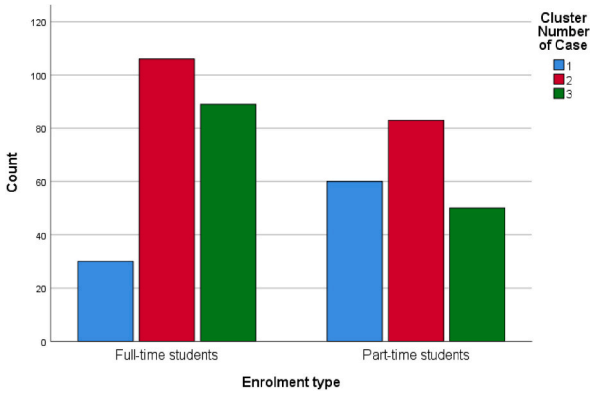

Fig. 9. Pre-service preschool teacher cluster membership according to the two types of enrolment in the course.

Table 16
Crosstabs relation between type of student enrolment and SDL profile.

			Cluster Number of Case			Total
			1	2	3	
Type of student enrolment	Full-time students	Count	30	106	89	225
		Expected Count	48.4	101.7	74.8	225,0
		% within Group	13.3%	47.1%	39.6%	100.0%
		Adjusted Residual	**−4.4**	0.8	**3.0**	
	Part-time students	Count	60	83	50	193
		Expected Count	41.6	87.3	64.2	193,0
		% within Group	31.1%	43.0%	25.9%	100.0%
		Adjusted Residual	**4.4**	−0.8	**−3.0**	
Total		Count	90	189	139	418
		Expected Count	90.0	189.0	139.0	418.0
		% within Group	21.5%	45.2%	33.3%	100.0%

dimension. Larger effect sizes for individual items were found for the dimensions of learning strategies and interpersonal skills, therefore, hypothesis H1 is confirmed.

With the research findings, we extend Song and Hill's [49] assertions that the planning, monitoring, and evaluation of the learning process is influenced by the learning environment that can motivate students to learn, and use resources, and strategies in a particular learning environment [49].

In the awareness construct, students began to look at teaching and learning somewhat differently after COVID-19 confinement. They realised that learning does not necessarily take place in the context of lectures and that professors play a greater role in their educational process than just imparting information. Online distance learning as a result of COVID-19 confinement has led students to rethink the role of university teachers. In this situation, students have realised that university teachers are not a "content source" but more of a learning guide. Certainly, most of the study is based on students' motivation, self-regulation, interest, search for resources, learning strategies, etc. [34].

Social constraints and online distance learning allowed students to combine their learning and personal daily routines. Students were able to adjust their lives, extend their sleep, eat during lectures, manage personal affairs, surf the Internet, etc. [49] This may explain why students during COVID-19 confinement online distance learning did not separate their learning routines and other commitments as much as those students before and after COVID-19 confinement [28,49].

Interestingly, students felt less responsible for identifying their weaker areas during the COVID-19 confinement than before. Also, in the evaluation, students rated the item related to the ability to perceive their strengths and weaknesses lower during the COVID-19 confinement than students did before. The rationale behind it could be the changes they experienced during the confinement. In the new situation, their cognitive resources were overwhelmed, which, according to the cognitive load theory, could cause confusion and distraction [90].

Progress can also be seen in self-reported scoring of learning strategies, learning activities, and interpersonal skills. Various teaching methods were rated better by students after the COVID-19 confinement. Students began to review new learning materials more frequently, research materials outside the curriculum, and participate in group discussions. This is to be expected given the way the learning process is implemented and the impeded communication during the COVID -19 confinement online distance learning. During the COVID-19 confinement, students rated their written and verbal communication to be lower than students before the COVID-19 confinement. This is also to be expected since there was less verbal communication during the online distance learning and the written expression was on a much larger scale than usual [49].

The largest statistically significant differences were found in attitudes toward interactive learning and a culturally diverse environment. Learning in a culturally diverse environment was not a major challenge for students during the COVID-19 confinement online distance learning, whereas it was recorded to be challenging both before and after. The latter could be explained because of school closure and limited contacts and travel. During this time, students might feel a greater need for social contact, changes in everyday life, and the changes that a different cultural environment would bring. Perhaps the reason also lies in the acquisition of ICT skills and competences that could bring the global community together [55]. Interestingly, students rated the item the highest in post-COVID-19 confinement face-to-face. The item regarding interactive learning is an expected consequence of COVID-19 confinement and online distance learning. As Song and Hill [49] report, online education is usually dominated by written communication, which can often lead to misunderstandings due to the lack of body language and facial expressions. During the closure, classes were held online. Communication between students and teachers was not as effective, and there were also problems with student assessment, especially in the fairness area of assessment [1,49,54,58]. For a while, there were no webinars in education at all, only communicate via email, online classrooms, etc. [1]. Since there was not as much interaction, students could see the importance of active learning and participation in lectures, which is why they rated this item slightly higher after their experience with online distance learning.

6.2. The effects of students' enrolment and educational modality on SDL

Hypothesis 2 predicted that the different educational modalities moderate the impact of student enrolment on the different dimensions of SDL. It was found that educational modality and the type of study enrolment have a moderating effect on SDL dimensions.

The modality and the type of study enrolment have a small size effect on awareness, learning strategies and interpersonal skills. Thus, we confirmed moderating effects of educational modalities on SDL. Warner [91] notes in his study that service learning offers the potential for interpersonal skills development. Thus, interpersonal skills are developed uniformly in pedagogy, such as from kindergarten work. This type of study enrolment has a significant effect on the learning activities dimension while the moderating effects of different educational modalities on SDL were not revealed. A sort of less active behaviour from students towards online distance education was also indicated in the study [57]. Students' perceptions of learning activities are similar regardless of study enrolment type. The latter suggests that the learning environment (face-to-face or online distance learning) and delivery method (number of contact hours) of the course do not shape, promote, or discourage students' perception of their learning activity skills. Thus, with their teaching strategies, methods, etc., university professors and other educators barely have any effect on students' learning activities.

It is important to note that the evaluation dimension of SDL is difficult to be impacted, as it is found the learning environment (face-to-face or online distance learning) had no moderating effect, while the type of study enrolment had a very small effect size [91]. In terms of self-evaluation, Alhazbi and Hasan [31] found in their study that there were no statistically significant differences between more successful and less successful students in terms of the synchronous learning environment, but there were indeed in the asynchronous online environment. Since there is less interaction in the asynchronous learning environment, the more academically successful students were more autonomous than their academically less successful peers in terms of structuring the environment, time management, and self-assessment [31]. Visual inspection suggests that full-time students rated their SDL evaluation dimension slightly higher, but not statistically significant. Different educational modalities did not have a significant effect on evaluation, but part-time students made progress during the COVID-19 confinement era and even reached the self-reported score that full-time students maintained in post-COVID-19 confinement face-to-face learning. This suggests evaluation skills of preservice preschool teachers are quite rigid. This might be due to the lack of supervision skills as argued by some authors [41,92].

6.3. SDL profiles in pre-service teachers

After a two-step cluster analysis, three profiles were revealed, named as low-, medium- and high-SDL profiles. The results showed no statistically significant differences among SDL profiles depending on the educational modality. It seems that the instrumental use of ICT to support learning, whether offline or online, on-site or remote, may affect SDL uniformly and could only be affected by students' level of computational thinking in solving real-world problems, as argued by Zeybek [21]. Therefore, hypothesis 3 is refuted.

Statistically, significant differences are not otherwise evident, but visual inspection suggests a different representation of clusters in each period. This can be explained by the stressful and new situation of distance learning that the students faced for the first time. This required a higher degree of self-direction and self-regulation from the students, which they began to develop more intensively during the first year of online distance learning. In contrast, the results after COVID-19 confinement showed higher mean scores for self-direction, which is anticipated since lessons with SDL improve SDL skills development [45]. These students already had experience with online distance learning and were able to develop self-direction to a slightly higher degree. We emphasize that there were no statistically significant differences regarding the formation of SDL profiles in terms of educational modalities.

In the clusters, there is also a different representation of students according to the type of study enrolment, with a larger number of part-time students rating themselves with a lower SDL, while full-time students rate their SDL slightly higher. Part-time students tend to already have a regular job and may have less time in their daily lives for in-depth study. These could be the reasons for the lower self-rating of each SDL dimension. In addition, they may not be as engaged in evaluating and assessing their learning process, strategy, methods, and activities, being occupied with their job and other obligations [93].

Nevertheless, there is an interesting observation within each cluster. It appears that regardless of educational modality or type of study enrolment, students rated both awareness and interpersonal skills higher. In all clusters, SDL dimensions increased according to self-reported scoring from learning activities, evaluation, and learning strategies to interpersonal skills and awareness. Our results confirm the findings of the study by Avsec and Ferk Savec [41].

6.4. Limitations and implications of the study and future work

There are some deficiencies in the research we have conducted. First, due to the nature of the work, most of the participants in preschool education were women, therefore, the sample was not analysed by gender. In addition, it should be emphasised that our analysis did not examine the same students in different educational modalities (pre-COVID-19 face-to-face learning, during COVID-19 confinement online distance learning and post-COVID-19 confinement face-to-face learning). The starting point for the study was generational comparability (e.g., minimum score required for enrolment in the program). In further research, it would be more useful to conduct a longitudinal study examining the same sample of students. It is also important to note that we used a self-report questionnaire to determine the degree of self-direction by its dimension. Authors point to problems in some SDL research, given the amount of attention paid to the quality of such learning and how accurately the achievement of set goals is self-assessed relative to actual value [9,33] since the results obtained are the consequence of students' perceptions. In addition to using a questionnaire, it would be useful to combine other data collection techniques, such as observation, and measurement tools to objectively measure the degree of self-directed learning through tasks, etc. In terms of generalization, it would be useful to include students from other faculties and universities. Finally, one of the more important obstacles to the research is the fact that, in addition to the Technical Education course, the students also took other courses from the curriculum of their study program, whose different working methods and strategies could also contribute to the results of this study.

Despite the above limitations, this study makes a unique contribution to the growing research on SDL and the advanced use of ICT

in education and educational practice to reduce the transactional distance in the remote learning environment. The findings presented in this study will be useful in expanding our understanding of the factors that influence both SDL and the targeted use of ICT in acquiring higher-order thinking skills necessary for effective preschool education and practice. This points to the need for additional interventions to develop 21st-century skills in prospective preschool teachers for teaching in virtual or real classrooms.

Considering the results, it would be necessary to further investigate the reasons why students rated the interpersonal skills item about perceiving studying in a culturally diverse environment as challenging, and highest in post-COVID-19 confinement face-to-face learning. In addition, further investigation of part-time students and their perceptions of SDL is needed. Due to their type of study and thus their mode of operation, these students would at best be expected to have a higher level of SDL development compared to full-time students, while they rated themselves lower.

When it comes to self-directed and self-regulated learning processes, it is also important to realise that these skills differ in terms of their dimensions as well as in terms of the student's interest in their subject, the content of the learning, and the subject competencies [94].

7. Conclusion

Self-directed learning is essential in today's world for its potential to develop 21st-century skills. Preschool education students have a great responsibility for their work. Their profession requires a high degree of self-direction, in order to successfully work with children and prepare them for further learning. Given the rapidly changing world and the new, unfamiliar situations we encounter, we found in our study that there are differences among students in different educational modalities in terms of their perceptions of SDL development. Differences occurred in all areas of SDL, with greater differences in interpersonal skills and learning strategies and the least in evaluation, which further proved to be more rigid. Differences were also found in the relationship between the modality and type of study enrolment. The latter influenced awareness, learning strategies, and interpersonal skills, while only the type of study enrolment had a small influence on the dimensions of learning activities and evaluation. Finally, we uncovered three different profiles showing that the majority of students are not at the highest level of self-direction. We cannot claim that educational modality forms different clusters, but only that different type of study enrolment has an impact on a student's placement in a particular cluster, e.g., full-time students rated their SDL skills higher on average than part-time students.

SDL can be influenced by the type of educational modality and the type of study enrolment. The study also revealed the varying degrees of flexibility in each dimension of SDL. The results and findings of the study are useful for designing courses to promote and develop SDL, both for higher education teachers and future teachers, as well as curriculum and educational policy developers.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and with the ethical principles and integrity in research of the University of Ljubljana, Slovenia. The study was approved by the Department of Physics and Technology Education of Faculty of Education at the University of Ljubljana (approval number 2018OFT05/11).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Declarations

Author contribution statement

Brina Kurent: Conceived and designed the experiments; Analysed and interpreted the data; Wrote the paper.Stanislav Avsec: Conceived and designed the experiments; Performed the experiments; Analysed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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