Proposing a Seamless Learning Experience Design (SLED) Framework Based on International Perspectives of Educators from Five Higher Education Institutions

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Abstract: Since seamless learning (SL) is still a rather unknown concept in higher education many educators classify it under the same categories as mobile, blended, online or hybrid learning. The purpose of this study is firstly to clarify the historical evolvement of the seamless learning concept over the past decades and, to position the seamless learning concept as it is understood today. Secondly, to find the most important concepts which can be proposed for a useful seamless learning experience design framework to assist educators with their course design. Considering this context, the research question for this study is formulated as follows: "Which concepts constitute a seamless learning experience design framework for students in higher education?" To answer this question, an inductive qualitative research analysis was conducted by collecting data from educators from countries on five continents on their views on this topic. Following a thematic coding approach of the combined dataset, five emerging themes crystallised, and are presented as part of a proposed Seamless Learning Experience Design (SLED) framework. They include core, positive, practical, human and design concepts – including sub-themes. The framework contributes to quality assurance processes in e-learning practices by providing a guide for developing seamless learning experiences for students.

Keywords: Seamless learning, Seamless learning experience, Innovation, Technology in education, Framework

1. Introduction

Since educational technology (EdTech) is evolving at an overwhelming pace, the pressure on educators to use technology and to improve learner engagement in order to achieve a high level of learning can be daunting. This study, therefore, proposes a framework for a seamless learning approach. The need for such a framework is supported by Bidarra and Rusman (2016, p.6) who argued that "to profit from the opportunities that the seamless learning spaces of today offer, we need an innovative perspective for the instructional design supported by an operational model of activities". Currently numerous learning models are available for e-learning, hybrid learning, blended learning and hyflex learning, but limited literature is available on the development of a seamless learning framework in higher education specifically (Marín, et al., 2016; Laru, et al., 2019; Yafie, et al., 2020).

Olszewski and Crompton (2020) and Milrad et, al. (2013) stated that knowledge delivery was no longer one of the foremost trials of education. The greatest challenge lies in designing learning experiences which will enable students to construct knowledge to engage and inspire them to learn. Considering this statement and the need for an operational model, this study focuses on establishing a useful framework for such a purpose.

Since educators may not be familiar with the definition of seamless learning, nor with the development of a seamless learning experience, the purpose of this study is to propose a seamless learning experience framework based on original data collected from educators at five international higher-education institutions, from Malaysia, New Zealand, The Netherlands, South Africa and the USA. The combined dataset was analysed inductively following a qualitative research coding process, where five overarching themes or concepts were identified. These include core, human, positive, practical and design concepts. The concepts constitute a Seamless Learning Experience Design (SLED) framework by answering the research question of the study: "Which concepts constitute a seamless learning experience design framework for students in higher education?" The article unfolds as follows: a short exploration of the historical review of relevant literature, a description of the qualitative methodology and findings (analysed themes and sub-themes, complemented by verbatim quotes), and finally, the discussion of the concepts of the SLED framework. It concludes with suggestions for implementing the SLED framework in the higher education environment.

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2. Theoretical Framework and Historical Literature Review

The theoretical stance of the study is informed by the theory of connectivism. Connectivism suggests that theories, thoughts, perspectives and general information are combined in a useful manner to make sense of the picture (Siemens, 2005). This approach is particularly relevant as seamless learning comprises connecting perspectives for generally separated environments. The next section includes a historical overview and theoretical conceptualisation of SL. Subsequently, evolving education technology frameworks are presented.

2.1 Historical Evolvement of the Term Seamless Learning

The term “seamless learning” dates back to the eighties when Papert (1987, pp.22-30) describes scenarios using books and computers for learning. Students would use their textbooks for homework and static computers during classwork. Knefelkamp (1991) indicates a need for a "seamless curriculum" to provide "holistic student education". He does not mention technology per se but speaks about experiential and in-service learning, which implies more than knowledge from books or learning in a classroom. Kuh (1996) published SL in connection with an "in-class and out-of-class" learning experience and a link between "formal and informal learning". The term "seamless learning" evolved when technology became more readily available to students as a personalised or collaborative learning tool.

Initially, Chan, et al. (2006, p.6) used the term Mobile Seamless Learning or MSL and defined it as:

> *[a] learning model where a student can learn whenever they are curious in a variety of scenarios and in which they can switch from one scenario or context (such as formal and informal learning, personal and social learning) to another easily and quickly using the personal device as a mediator.*

Sharples, et al. (2012, p.24) used the Seamless Learning term and defined it as:

> *Seamless learning is when a person experiences a continuity of learning, and consciously bridges the multifaceted learning efforts, across a combination of locations, times, technologies or social settings.*

Wong (2015) undertook a systematic literature review exploring publications on MSL and SL from 2006 to 2014. He noticed a gradual shift in researchers' perceptions of MSL from a technology-enabling perspective to a curriculum design perspective to the foregrounding of the roles of learning spaces to the fostering of learning culture (Wong, 2015, p.6). After 2015 the word MSL was no longer used and replaced by the shorter SL version. In 2019, Rusman, et al. (2019) added "personal experiences both in and across contexts" to the SL definition.

In Figure 1, the use of smartphones among different age groups, education levels and gender differences is presented. The figure indicates the high use of smartphones among the student population. These statistics support the notion that seamless learning is becoming even more accessible and relevant in higher education.

With more clarity on the definition of seamless learning, the next part of the literature study focuses on existing frameworks as motivation for the proposed framework of this study.

In the context of this study, the ADDIE Instructional Design model is considered as the design approach aiming at developing a framework for seamless learning (Kurt, 2018). This model is historically known to be a functional and encompassing design approach and includes an iterative process from analysis to development, to design, to implementation and evaluation, and then to improve where necessary. This approach also allows for an existing framework to evolve to a more appropriate approach as continuous changes occur on various levels. The following frameworks are presented as evolving frameworks from existing models for learning with educational technology and have gone through similar design processes as per the ADDIE model. The ultimate goal of these frameworks is to “promote quality teaching on campus, enrich the student learning experience, and facilitate the career development of professors in the area of pedagogy and teaching innovation” (Vaughan, et al., 2017, p.105). These frameworks are presented in the following section.

Younger, better-educated more likely to own smartphones

% of adults who own a smartphone

		Age				Education			Gender		
	TOTAL	18-34	35-49	50+	Youngest-Oldest Diff	More education	Less education	Diff	Men	Women	Diff
	%	%	%	%		%	%		%	%	
Advanced economies											
South Korea	95	99	100	91	+8	99	90	+9	96	95	+1
Israel	88	91	94	80	+11	95	83	+12	88	89	-1
Netherlands	87	99	98	74	+25	95	82	+13	89	85	+4
Sweden	86	98	92	77	+21	91	83	+8	88	85	+3
Australia	81	97	89	68	+29	89	77	+12	80	82	-2
U.S.	81	95	92	67	+28	88	75	+13	82	80	+2
Spain	80	95	93	60	+35	94	75	+19	81	79	+2
Germany	78	98	90	64	+34	85	76	+9	81	75	+6
UK	76	93	90	60	+33	87	73	+14	81	71	+10
France	75	97	91	53	+44	88	63	+25	79	71	+8
Italy	71	98	91	48	+50	96	67	+29	75	68	+7
Argentina	68	84	77	42	+42	86	65	+21	67	68	-1
Canada	66	90	85	43	+47	74	55	+19	71	61	+10
Japan	66	96	93	44	+52	79	58	+21	69	63	+6
Hungary	64	92	84	35	+57	85	57	+28	69	59	+10
Poland	63	93	87	35	+58	82	57	+25	65	62	+3
Greece	59	95	83	29	+66	86	48	+38	59	58	+1
Russia	59	91	76	26	+65	72	39	+33	64	55	+9
Emerging economies											
Brazil	60	85	63	32	+53	86	37	+49	63	57	+6
South Africa	60	73	59	35	+38	77	47	+30	61	59	+2
Philippines	55	74	50	27	+47	70	29	+41	52	57	-5
Mexico	52	66	53	30	+36	79	35	+44	57	48	+9
Tunisia	45	75	35	18	+57	70	28	+42	48	42	+6
Indonesia	42	66	32	13	+53	72	27	+45	45	39	+6
Kenya	41	51	27	18	+33	71	24	+47	47	36	+11
Nigeria	39	48	31	20	+28	51	6	+45	47	31	+16
India	24	37	21	8	+29	55	11	+44	34	15	+19

Figure 1: Statistics on smartphone users (Taylor and Silver, 2019, p.13)

2.2 Overview of Evolving Learning Frameworks Within the Educational Technology Environment

Various learning frameworks, including Educational Technology, have been developed over the past decades. These frameworks include the TPACK framework (Mishra and Koehler, 2006), the FRAME model (Koole, 2009), the Seamless-learning Design model (Wong, 2012) and the Multi-Device Learning Framework (MDLF) (Krull and Duart, 2017) (see Figure 2).

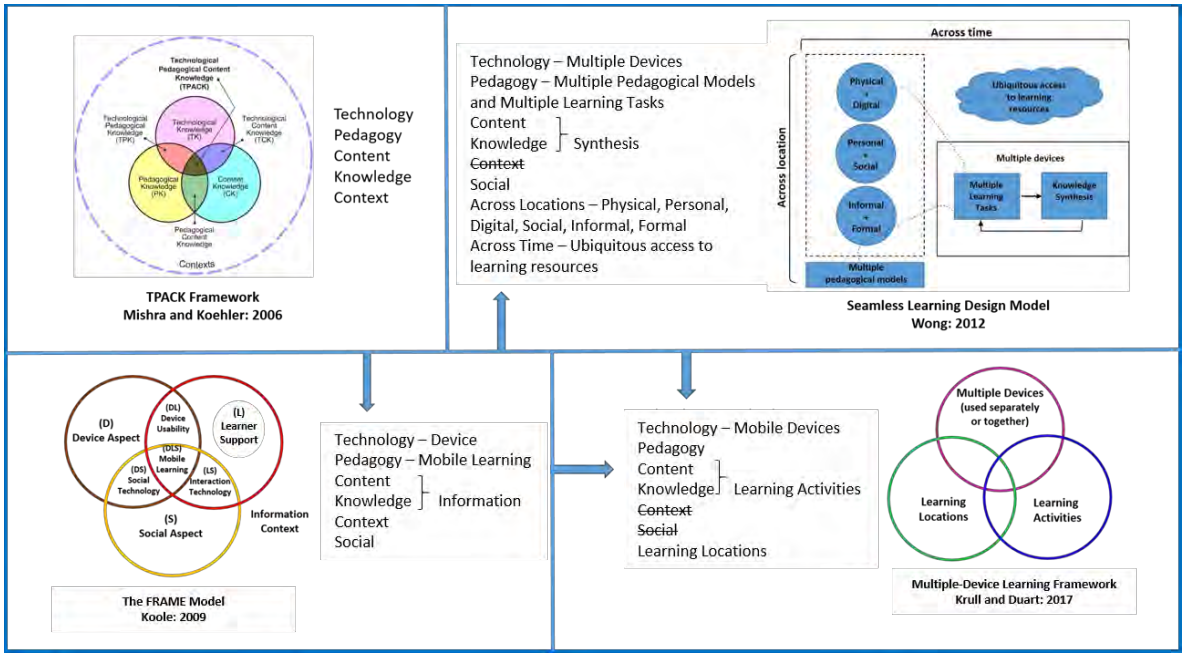

Figure 2: Educational Technology Frameworks (2022) (Note: The strike-through "context" and "social" indicate that these concepts were absent in these frameworks.)

Mishra and Koehler (2006) identify five components of successful EdTech learning experiences: Technology, Pedagogy, Content and Knowledge applied in a specific Context. The identified gap for a seamless learning experience is that they do not include learning environments. Koole (2009) builds on the TPACK framework by

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compiling a FRAME model for mobile learning, adding a social component that comes with the mobile device's connectivity affordance and recognising the importance of learner support as supported by comprehensive studies by Engstrom and Tinto (2008). Again, no specific reference to transitioning from one learning environment to another is included. The gap identified is supported by Gagne, et al. (2005), who contend that a specific objective needs to be identified for a successful learning experience, which includes a well-planned program with smooth transitions between various interactions with the content, as also mentioned by Owen (2014).

Three years later, Wong (2012) designed an SL framework that includes the five TPACK components and adds Time, Location and Ubiquity as new concepts. Again, switching between learning environments is not mentioned. In 2017, Krull and Duart (2017) also used the main concepts of the TPACK model but combined Pedagogy, Content and Knowledge as part of the learning activities. They added multiple devices as part of the Technology component and various Learning locations as a part of the Multiple Device framework, acknowledging the greater importance of mobility between multiple environments. This framework incorporates location transition options that are important for seamless learning but could be explained in more detail. The shortcomings identified in the Krull and Duart study for seamless learning are human and positive concepts which will be elaborated on in the discussion section of this study. Furthermore, equal access (Chan, et al., 2006; Gillwald and Mothobi, 2018; Kukulska-Hulme, et al., 2021), affordability of technology (De Villiers, 2020), adoption of infrastructure (Antwi-Boampong, 2020) and “enlarged learning environments” Wong (2012, p.22) are identified gaps for a successful seamless learning experience. All of these are guided by institutional policies (Graham, Woodfield and Harrison, 2013). According to Sharples, et al. (2012), SL includes a set of meta-cognitive abilities and needs a framework that helps to establish valuable guidelines. Wong (2015, p.9) advocates for SL as follows: "The key is to facilitate and nurture genuine transformations of beliefs about and habits of learning among the learners."

In conclusion, the existing frameworks may have been relevant for a specific time in a specific context. The introduction of the TPACK framework (Mishra and Koehler, 2006) was developed when technology was added to the learning approach as a whole. However, most technologies were static and not used outside the classroom. This framework is too limited for a seamless learning approach with the emphasis on flexibility. Although the FRAME model for mobile learning, (Koole, 2009) includes a social aspect, the smooth transitioning between learning environments needs to be more explicit for a seamless learning experience. The SL framework proposed by Wong (2012) focuses on the ubiquity and flexibility mobile technology affords. Still, since more aspects are involved, it needs to be adjusted for a seamless learning experience. Sharples, et al. (2012) points to the metacognitive abilities of the student that need to be integrated into the SL approach, while Wong (2015) mentions beliefs and habits. These gaps necessary for an even more comprehensive SL experience framework are incentives for this study.

3. Method

Participants from HEIs in five different countries (South Africa, the United States of America, the Netherlands, New Zealand and Malaysia) participated in the study. Disney's Creative Strategy Method, as suggested by Rusman, Tan, and Firssova (2018), was applied and included a workshop where a creative brainstorming session was conducted in each country respectively. The participants were assigned one of three roles: the dreamer, the realist or the critic (Elmansy, 2015; McGuinnes, 2009). The dreamer thinks creatively, passionately, enthusiastically, and without restrictions about the solutions, inspirations, and benefits of a specific aspect. In contrast, the person who assumes the realist's role adopts more logical thinking, including manageable ideas, necessary resources, and timelines. The critic is the voice of reason who illuminates barriers, risks, and weaknesses and gives constructive criticism. The method is described in more detail in the book “Seamless learning in Higher Education” (Hambrock, et al., 2020, pp.5-12).

Creswell (2014, pp.251) states ‘When qualitative researchers provide detailed descriptions of the setting, for example, or offer many perspectives about a theme, the results become more realistic and richer. This procedure can add to the validity of the findings.” Based on this statement a qualitative research approach is followed and the data is presented verbatim.

3.1 Sampling and Population

The target population consisted of educators from five universities from five countries on five respective continents. They were selected by purposive sampling (specifically selected participants) and snowball sampling

(suggested by participants) (Jupp, 2006, pp.88, 196). The inclusion criterion for the purposive sampling was that the participants needed to be part of the academic staff. The population is indicated in Table 1.

Table 1: Participants of the study

	Malaysia	The Netherlands	New Zealand	South Africa	USA
N	12	21	8	20	17
Male	4	11	4	4	8
Female	8	10	4	16	9

3.2 Data Collection

The data were collected during a workshop that started with an introduction to the definition of SL and an explanation of the Disney method. The statement: "Seamless learning experiences should become a standard component within your institution's curriculum" was presented to the participants, and they were requested to give their assigned perspectives on Post-it notes. After a 20-minute brainstorming session, the thoughts of each group were presented to the rest of the participants, followed by a discussion.

3.3 Data Analysis

In order to find overall commonalities, the comments from the participants of the five countries were combined as one dataset. For the analysis of the data, an interpretive inductive approach was followed. The process is supported by Burnard et al. (2008, p.429), who describe inductive analysis as "analysing data with little or no predetermined theory, structure or framework", and by Braun and Clark (2006) who refer to inductive analysis as a form of thematic analysis where themes are identified within a data set. Additionally, Saldãna (2013) supports the unique researcher perspective, as applied in this study, by stating that a thematic analysis recognises that the analysis is informed by the researcher's unique and subjective perspective. An example of the coding process by Saldana (2013) is presented in Figure 3.

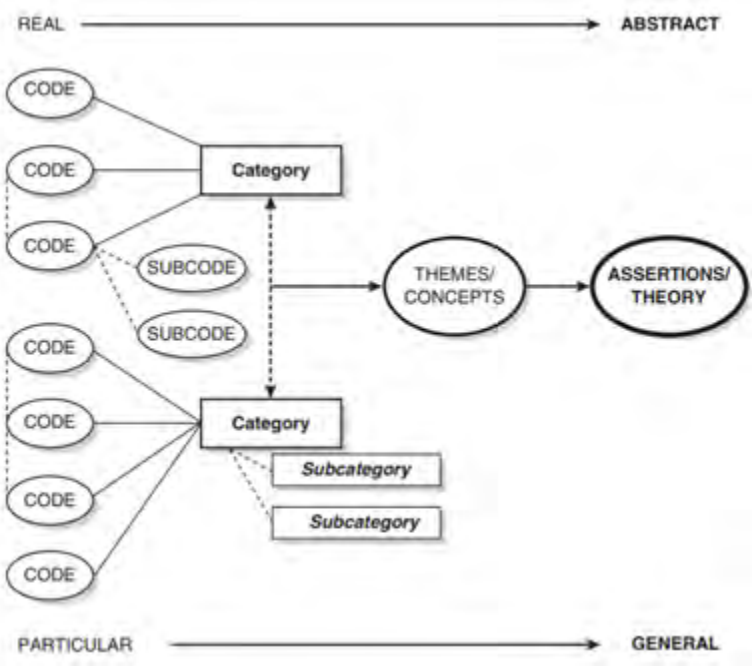

Figure 3: Inductive analysis with coding process: From code to theory (Saldãna, 2013, p.12)

Figure 4 (below) is the visual representation of the research collection and analysis process used for this study. First, the workshops were conducted by collecting statements from the three views (the dreamers, the critics and the realists). Then the data was combined, coded and organised into themes which crystalised as five concepts.

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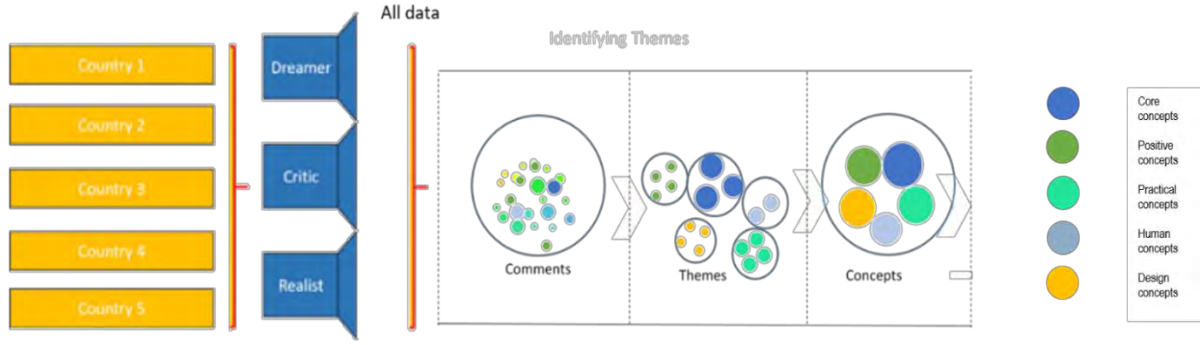

Figure 4: A diagram of the data analysis and coding process

To ensure that the analysis includes reliability, validity and trustworthiness, the researchers followed the approach of Merriam and Tisdell (2016, pp.237-238), who state that the data should be analysed ethically by giving attention to the conceptualisation, data collection, analysing, interpreting and presenting the data. To address the possible bias of the researcher, a peer review of the data analysis process was done by the co-author. This approach is supported by Merriam and Tisdell (2016) and Creswell and Creswell (2018), who mention that a colleague who is familiar with the research can do peer review (or peer examination) by looking at the raw data and assess whether the findings are plausible.

For the process of coding and identifying themes and concepts, *Atlas.ti 8,* a computer-assisted qualitative data analysis software program, was used. Friese (2019) reports that the benefits of this software program include visualising themes by using network functions and visually integrating the findings to better understand the phenomenon being studied. The identified themes, sub-themes and explanatory quotes from the participants are presented below. *Atlas.ti 8* uses a number system to identify the participants. The first number represents the country, and the second the number of the comment of the country's data set. The country identifiers are as follows: 1 (South Africa), 3 (New Zealand), 4 (USA), 5 (Malaysia), and 6 (The Netherlands) (there is not a country number 2). Only verbatim quotes were provided with quotation marks.

4. Findings

In this section, the overarching themes are presented to answer the research question: Which concepts constitute a seamless learning experience design framework for students in higher education?" The sub-themes are presented in Table 2 to Table 6 with the number of comments within each sub-theme in brackets. These comments and numbers are also illustrated by the graphs and thereafter the actual words in verbatim are discussed within the HEI context. This approach contributes to a deeper and richer understanding of the data (Creswell, 2014, pp.215).

4.1 Core concepts

The core concepts include sub-themes that either contribute to achieving an SL experience for students and educators or point to aspects needed to accomplish or improve an SL result.

Table 2: Sub-themes and the number of associated comments

Alternative teaching and learning (71)	Measurement of success (2)
Challenges (90)	Network with other students (13)
Experts' engagement (14)	Scholarship (11)
Innovation (26)	

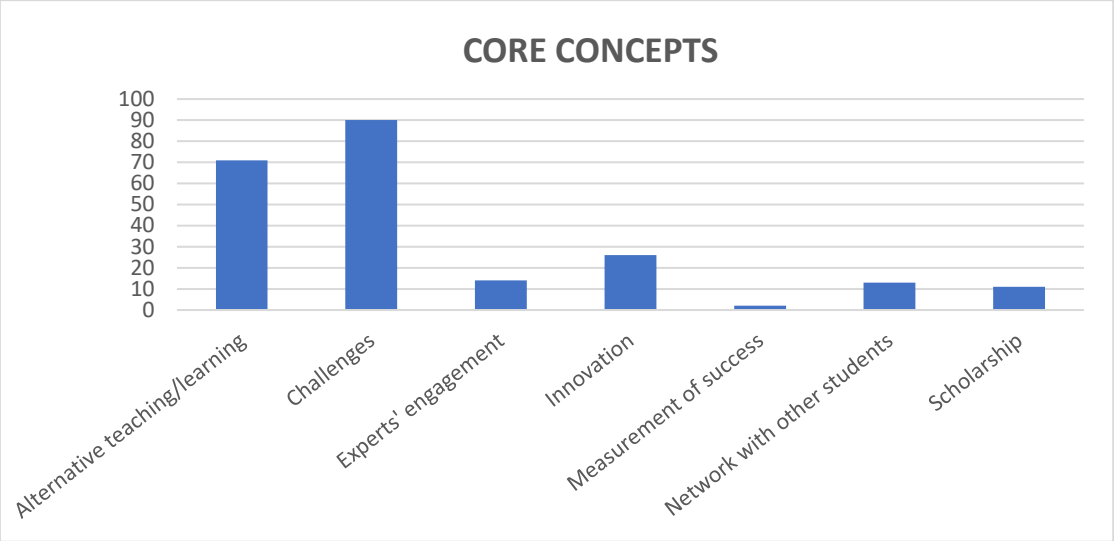

Figure 5: Sub-themes of theme 1: Core concepts

4.1.1 Alternative teaching and learning opportunities

One participant described SL as "a university without walls" (4:11); others said that SL has no barriers regarding location (3:14; 4:10; 1:50). They also mentioned that it would enhance the flow experience (1:78) and allow students to utilise all their senses while learning (1:70; 1:87). SL permits the students to "experience real-world scenarios" (1:94, 6:19) where learning can happen anywhere (3:5; 3:4; 3:16). They can connect to the community (1:121) and improve contextual knowledge (1:128). Learning is not one-dimensional (3:22; 3:13), and students go to places "where they would not normally go" (4:1). It is an "unbiased learning environment" (1:120), a "cross-cultural classroom" (4:32), and it allows for "exploration" (4:3), "interaction" (4:8) and "diverse learning methods" (4:52; 4:49) and learning styles (4:115; 1:107).

Furthermore, the participants mentioned that SL could integrate practice and theory (3:8), especially when aided by innovative applications (6:14; 3:14). Other suggestions include "virtual trainers" (1:125), virtual simulation of settings like businesses and hospitals (4:35; 4:61; 4:2); "artificial intelligence tools" (4:25) and lecturers being present while students are doing practical work (1:96; 6:25).

4.1.2 Challenges

Challenges include technology failures (6:51; 6:39; 4:117; 4:107; 4:50), “technical issues” (4:88), power loss and connectivity (4:88; 1:23; 4:100), capacity (6:52), lack of IT specialists (5:3; 4:104), Wi-Fi accessibility (1:34; 4:56), “stability” (1:97), data, support and cost (1:4; 1:12; 4:50; 4:71; 4:92). Digital literacy deficiency (4:108; 4:58; 5:10; 1:51; 4:105) may be a hindrance to successful implementation. The extra workload for the lecturers (4:91; 1:20; 1:38; 6:69), curriculum changes (1:41; 1:42), and time consumption (4:39) were raised as challenges for the lecturers. More concerned comments included that SL is not always practical for all kinds of content (1:54; 6:68) and that assessment may be difficult (5:8; 3:24; 6:66; 1:43). This raises the question of support and infrastructure (1:11; 1:21; 4:63) and how to implement SL in the higher education realm (4:65; 4:67; 4:112). Other limitations include “lack of training” (5:11), “lack of expertise” (5:14), and the difficulty of implementation (6:59; 6:61).

4.1.3 Expert engagement

The lecturers (1:145; 1:152) and the students (1:153; 6:27) must partner with experts in the industry (1:160; 6:47; 6:37; 5:27). One suggestion was that students should have "live interviews with experts in their environment" (4:4). It was repeatedly suggested not to re-invent the wheel but to get advice from people who have done it before (1:165; 1:179; 1:184).

4.1.4 Innovation

The application of SL may stimulate creativity, innovation, unique learning opportunities (3:15; 1:110; 1:85) and also challenge students (1:119). New ways of learning may include that learning can take the form of "exploration, guided by questions and answers" (4:3). Innovative ideas are, for example, "cross-cultural" (4:32), virtual (4:33), and "hologram" (5:15) classrooms and incorporating AR/VR to support learning (3:42).

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4.1.5 Measurement of success

There is "hardly any empirical basis" (6:63) to support the effectiveness of SL. Research is necessary to "monitor and evaluate the effectiveness of seamless learning and the relationship with student success" (1:131). This also means that feedback from students needs to be included to learn from them what could be improved.

4.1.6 Network with other students

SL can improve "interpersonal social learning" (1:86) and "collaborative learning and social constructionism" (1:112) by using a "centralised social interactive LMS" (3:17). They can study a topic in a group (4:7) and "consult with each other for group assignments" (6:22). Classes are accessible to anyone, anywhere (3:111; 4:5; 4:111).

4.1.7 Scholarship

SL can create a culture of scholarship of teaching and learning (1:175; 1:10). This is done by relating to other disciplines (1:77), "including authentic contexts" (1:89), and developing innovative apps "that combine theory and practice" (6:14). Some participants comment that it is impractical to make it compulsory for all modules (1:49; 1:54). A panel in a department needs to decide on the best approach for including SL (1:186).

4.2 Positive Concepts

The positive concepts include aspects that contribute to achieving successful SL experiences for the student.

Table 3: Sub-themes and the number of associated comments

Student-centred approach (28)	Real-time interaction (20)
Globalisation (17)	Remote access (15)
Practical experience (16)	Research opportunities (7)
Preparation for future (8)	

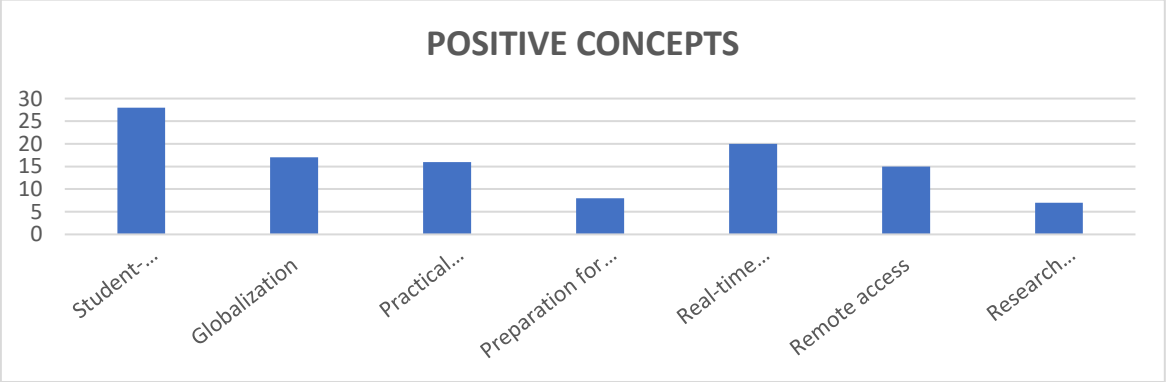

Figure 6: Sub-themes of theme 2: Positive concepts

4.2.1 Student-centred approach

The student needs to be central in the design. Students with disabilities (1:108) and different learning styles/methods (3:29; 4:115; 4:52; 4:64) should be accommodated. SL can encourage self-regulated learning (1:109; 4:78) and "enhance critical thinking and reasoning skills" (1:111) when students are allowed to give input (6:28; 4:70; 4:69). The application of SL may increase “learner engagement” (4:18; 4:74) and “motivation” (4:17; 3:15; 1:79).

4.2.2 Globalisation

A universal platform can be created (3:19) to incorporate "global methods and resources" (4:29). The "online environment allows for a more diverse global perspective" (4:60). The participants even mentioned a "virtual international classroom" (4:33) from diverse cultures (4:32; 4:60). One participant expressed it as follows: "technology allows a global community in your hands." Students can learn anywhere (3:16; 3:4; 3:5; 4:14; 4:98; 4:13; 4:10).

4.2.3 Practical experience

Quite a few participants reflected on the benefits of learning from experience (6:12; 1:74; 6:20; 6:30; 1:116; 1:69; 1:78) and linking skills and practices to real life (6:7; 6:31; 3:8; 6:19; 4:44). Exposure could "improve their contacts and employability" (1:127).

4.2.4 Preparation for the future

In line with and closely related to the previous sub-theme is the assumption that SL helps students to be better prepared for the future. One participant stated: "Through seamless learning, students will be better equipped for life after graduation" (1:63). Professional development is needed (4:77), and the scenario of talking to experts and experiencing real-life situations "will create better employers" (1:117).

4.2.5 Real-time interaction

The possibility of real-time (immediate) feedback (1:58) and connection with any role player or fellow students are advantageous. Connectedness is high on the list of positive aspects, and the fact that several students can interact simultaneously (6:3; 6:25; 6:11) and even "communicate with one another or the lecturer outside official class time" (1:72) is appealing. It will "support more connected learning" (3:10). Students doing clinical or practical work can contact the lecturers directly (1:56; 1:96). Assessment can be done through written reports on the cloud, where the lecturers can have immediate access (1:126; 6:16). Connectivity opens the doors to alternative work methods such as interactive classes (1:126).

4.2.6 Remote access

With the use of technology (6:9; 6:10) and the alternative strategies of SL, remote learning is possible (3:11; 3:10; 4:20; 4:5; 4:14; 4:13) at any time. The learners can learn "from their own situation with their own resources and aptitude" (6:4), where information is available at any time (5:26; 4:76; 4:16; 4:57). Students from different cities (4:5; 4:6) can be connected. There are "no barriers" (3:14; 6:1).

4.2.7 Research opportunities

The relatively new field of SL can result in "increased research output and publications" (1:95) and increases research possibilities (1:114; 4:68). Results can be shared at conferences (1:176), and a database can be created "for future research" (1:93). Publications can enhance the marketing opportunities of the institution's innovative capability (1:150).

4.3 Practical Concepts

The practical concepts include the technical, financial and legal access and support necessary for successful, SL implementation.

Table 4: Sub-themes and the number of associated comments

Data and Wi-Fi (32)	Poicies (6)
Devices and hardware (18)	Software (13)
Funding and cost (19)	Support (26)
Infrastructure (17)	Technology (53)

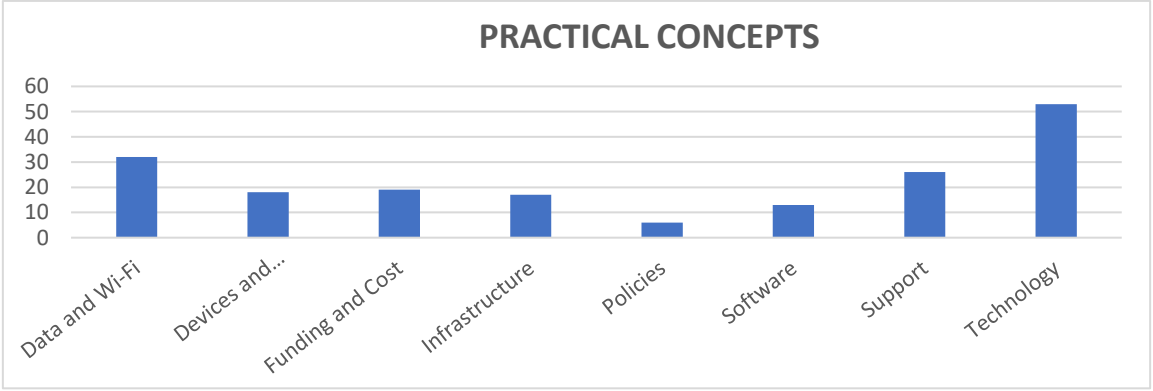

Figure 7: Sub-themes of theme 3: Practical concepts

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4.3.1 Data and WiFi

Many respondents emphasised the issues of data and Wi-Fi (1:4; 1:12; 1:34; 1:134) connectivity (4:88; 1:134; 1:23; 4:56; 3:11), unstable Wi-Fi networks (1:97) and accessibility (1:34; 1:135). Access to resources (1:37; 3:25; 4:89; 4:70; 1:132; 3:40), technology (1:36; 1:122; 3:25; 4:86) and information (4:57; 4:16; 4:73; 4:76) is required.

4.3.2 Devices and hardware

Different aspects of devices and hardware seem to present possible hindrances. Ideally, each student must have a tablet or a smartphone (5:28; 1:100; 1:59; 4:71; 5:7; 3:6) but stolen devices (1:33) and insurance (1:151) are concerns. Possible solutions are that the institution must “partner with tech industry” (1:154) and issue devices (1:138; 4:31; 1:101; 1:155; 4:86) where the students sign contracts with the companies (1:155).

4.3.3 Funding and cost

Most of the respondents who commented on funding and cost agreed that it is a concern (1:23; 1:18; 1:47; 1:52; 4:36; 4:51; 4:59; 4:92; 6:50; 4:81; 5:30; 6:69); comments mentioned “financial issues” (5:5) and that “software and technology is [sic] expensive” (4:36). Students need “ongoing support and funding” (3:46), high-speed Wi-Fi (5:16; 1:135) and subsidised (5:25) or free data (1:123; 1:102; 1:159; 4:79; 1:67; 5:25).

4.3.4 Infrastructure

When implementing a different learning strategy such as SL, one needs support and infrastructure (1:11; 1:21; 4:28; 4:63; 5:1). There should be "commitment from top to bottom" (1:166), "cooperation across faculty" (6:46), and the WiFi speed must be adequate across campus (1:135).

4.3.5 Policies

Policies are essential (1:170; 6:42), and "assessment policies must be improved" (1:157). A guiding document/framework must be distributed (1:198), and all lecturers "need to understand what seamless learning is" (1:148) and what "good practice entails” (1:132).

4.3.6 Software

Exciting suggestions were made regarding software and apps for SL. A few are apps that "keep track of your practical hours spent" (1:192), "measure the progress" (6:13), and “disseminate assignments randomly” (6:15). The development of apps must be supported (3:2; 3:14). It would help to have one consistent learning platform (3:20; 3:38).

4.3.7 Support

Excellent support is necessary at institutional level, like a call centre (1:164; 1:167; 1:105’4:27), support services (4:45; 4:72; 1:161; 1:162; 1:195), a support structure for staff implementation and training (3:40; 1:156; 3:39 1:149; 6:71; 1:172) (for example, AI tutors (4:26) and IT specialists (5:3; 6:37; 6:38)). Students also need training and support (1:147; 3:26; 4:28).

4.3.8 Technology

Given that SL is dependent on technology, a myriad of comments were made regarding technology (1:188; 1:185; 1:4; 1:12; 4:51; 4:71; 4:75; 1:136). Free technology would be advantageous (1:123). The staff (1:98) and students (1:99) must be motivated to use technology. Positive aspects include that "technology provides a connection between students over a distance" (6:10) and "technology allows a global community in your hands" (4:53). Negative aspects were that there could be "chaos in platforms" (6:49), and not all students and staff have access to technology (3:25).

4.4 Human Concepts

The human concepts include aspects referring to educators’ and students' ability, availability, and interest in implementing an SL approach.

Table 5: Sub-themes and the number of associated comments

Skillset (21)	Equality (12)
Time-consuming (12)	Mindset (39)
Training (34)	Positive outlook (11)
Differences in norms and convictions (5)	

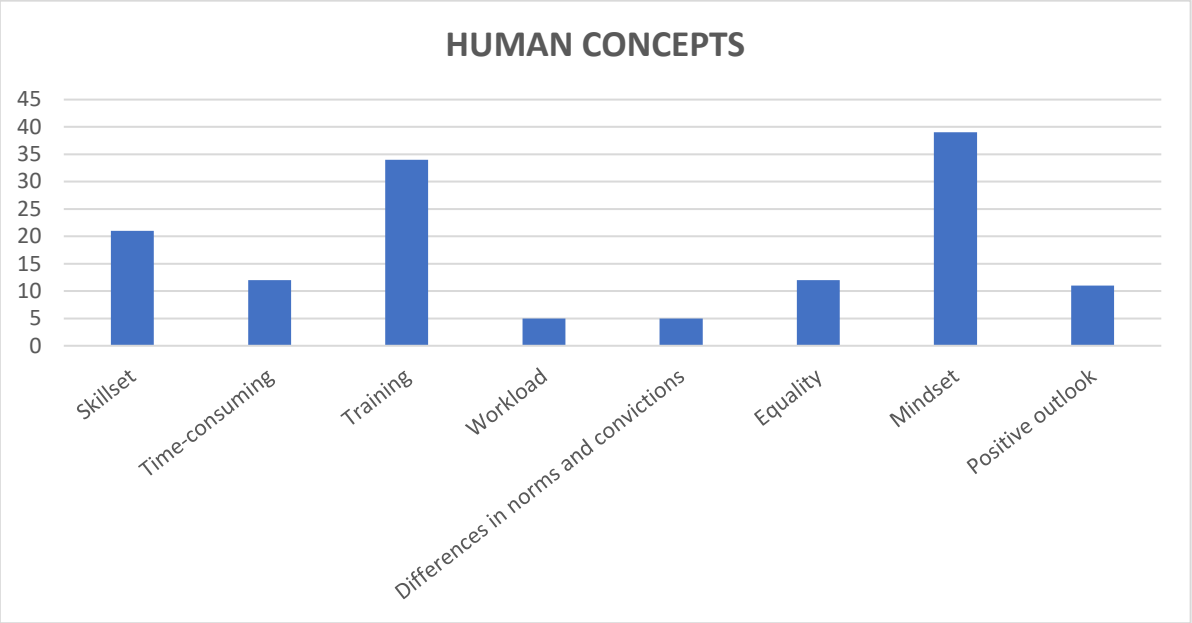

Figure 8: Sub-themes of theme 4: Human concepts

4.4.1 Skillset

The students' "base knowledge level" (1:6) and "computer literacy" (1:30) may be problematic, and "some students may be left behind" (1:13; 1:22). They need to be able to "apply knowledge" (1:65) and be digitally literate and skilled (5:10; 4:105). Implementing SL can help students get employment because of their skills (6:7; 6:8). The "computer literacy of lecturers" (1:15) and the fact that they are not all "tech savvy" (1:51) and perhaps "unable/unqualified/uncomfortable" (3:27) may be concerning.

4.4.2 Time-consuming

Implementing SL will be time-consuming (1:53; 5:12; 6:64; 6:73) and create extra work for students (1:27) and lecturers (1:38; 1:20; 4:91; 6:58). Some concerns were expressed as follows: "Time/experience available for developing digital activities" (6:73); "The time and resources to re-create assignments to match new modes of learning could become too great" (3:24).

4.4.3 Training

Workshops and training must be provided (1:171; 1:174; 3:35; 3:39; 4:42; 4:58; 4:109; 4:110; 4:121; 5:11; 5:23; 6:42; 1:147; 4:23). Students need instruction and training (6:35; 3:26; 1:130; 4:80). Lecturers must be trained (6:40; 4:80; 6:53; 6:71) in "effective use of the technology required" (1:146) and implementing SL (1:141; 1:103). They need to understand what “good practice entails” (1:132) and “what seamless learning” (1:148) is.

4.4.4 Differences in norms and convictions

Problems, according to some participants, can be "differences in cultural convictions, moral norms, and political affiliations" (1:8) and "less political, racial and gender equality" (1:84) when implementing SL. Others consider differences an advantage, stating that it is like sitting in on a global class (4:32) and that "geographically dispersed people can be engaged" (4:111).

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4.4.5 Equality

There needs to be equality of "interactions and learning" (1:22), fairness to all (1:80), "equity of access" (3:23), "inclusion of all disabilities" (1:88) and increased diversity (4:34; 4:34; 4:52; 4:94). Students must all get "the same chance to succeed" (3:28) and be able to participate fully and equally (4:93). Most of the resources must be open-sourced (3:49).

4.4.6 Mindset

Regarding a positive mindset, there must be "no critical disposition" (1:90), and everyone must be "stimulated and inspired" (1:118). Students (1:81; 1:99) and staff (1:98) have to be motivated to use technology. Awareness (5:4; 4:75), responsibility (4:55), integrity (5:9) and a good attitude (5:13) are crucial. Lecturers must have the "right mindset and not be offended" (1:14). Students "won't buy in if not done perfectly" (1:29). Some may be "uninspired and lazy" (1:32), so they need to be challenged (1:119).

4.4.7 Positive outlook

Overall, the participants were optimistic about the implementation of SL. A few examples are: "Yes we can do it!" (1:189), "How can we make this work?" (1:190), "I am going to make it work" (1:193), "So let us start planning" (1:196), and "This is very exciting" (1:197).

4.5 Design Concepts

The design concepts include the aspects needed for designing a successful SL experience.

Table 6: Sub-themes and the number of associated comments

Application of knowledge (8)	Feasibility (14)
Assessment (18)	Implementation (37)
Curriculum and design (36)	Learning strategies (25)

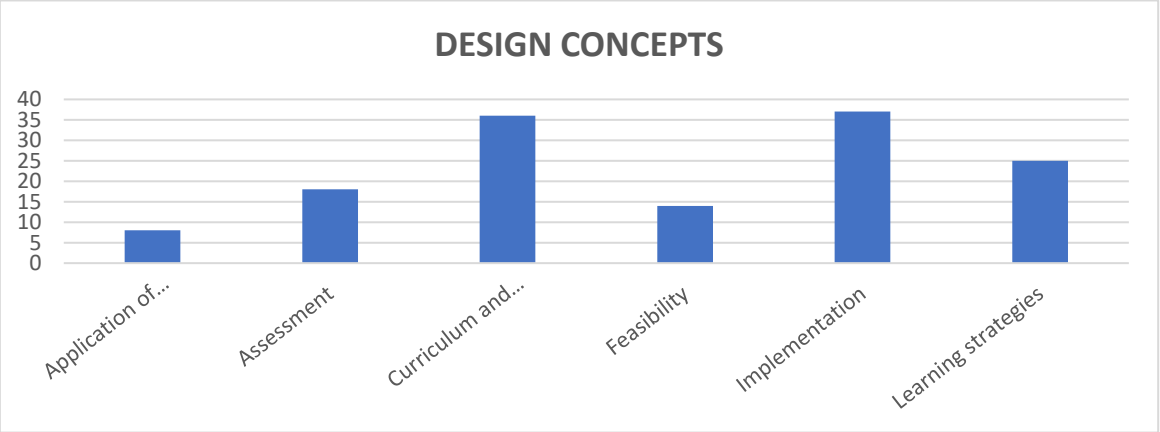

Figure 9: Sub-themes of theme 5: Design concepts

4.5.1 Application of knowledge

Students must be able to apply knowledge (1:65; 6:30), e.g., taking on "various roles" like a lawyer, prosecutor, judge (6:17; 6:19) or compiling a marketing plan (1:66). There is also the potential to "integrate practice and work placement learning into the classroom" (3:8).

4.5.2 Assessment

The participants were worried about assessment strategies (1:117; 1:43; 3:24; 5:8; 6:66), adding "different types of assessment methods must be explored to complement different methods of learning" (1:71), a "more proactive use of technology" is needed (4:19), as is "using apps for measuring progress" (6:13). Some participants favour continuous assessment and feedback (1:140; 1:68), whereas others want to "measure students' performance after relevant time" (1:139) and compare it with a baseline (1:142; 1:139).

4.5.3 Curriculum and design

Concerns were raised about further curriculum changes (1:41; 1:42; 1:158; 4:116; 5:24), that "different architectures [are] needed" (3:48), and not all modules can implement SL (1:35; 1:104; 1:2; 6:68). Regarding design, it was suggested that "instructional design" (1:163), "effective and conscious design" (3:37), a "question-answer model" (6:23), and an initial steps-design phase" (6:48) be pursued. For this, you need educational experts (6:47, 6:73). Other recommendations were the use of "AI tools" (4:25) and that the module must be redesigned and not merely uploaded to an online platform (3:34).

4.5.4 Feasibility

Questions asked were: "Is this feasible?" (4:82), "Do the benefits outweigh the barriers?" (4:83), "Can the university's servers handle the strain?" (1:28), and "Doesn't all this deduct from the education itself?" (6:55). A pilot program should iron out any errors and assure the project's feasibility (6:36).

4.5.5 Implementation

Participant comments included aspects like class sizes (1:1; 1:7; 1:16), implementation problems (5:2; 4:65; 3:33; 4:48; 4:40), one needs a plan of action and coordination (4:66; 6:43; 6:58; 4:112) and good technical support (4:46). Decisions must be communicated to all staff (1:136; 1:168) and students (1:143; 6:34; 6:41) and the time of implementation must be considered carefully (4:40).

4.5.6 Learning strategies

Positive remarks included that it will "make learning more connected" (3:10; 3:12), "encourage creative and unique learning opportunities" (3:15) and change learning from one-dimensional to multi-dimensional (3:13; 3:22). Online learning allows for a "philosophy of open education" (3:21), "advanced engagement" (4:95) and an "accelerated curriculum". Proposals were that "people need straightforward instructions, processes and expectations" (4:118), "new modalities need to have value academically" (4:102), and "perceptions need to be managed during conceptualisation" (4:101).

5. Discussion

The following section includes a reflection on the over-arching themes that emerged during the data analysis. The themes are discussed in the context of best practices for SL, which are presented as the Core, Positive, Practical, Human and Design concepts. They are discussed with reference to the literature.

5.1 Core Concepts

A concern that emerged during the data analysis was the importance of understanding SL: educators need clarity about what SL pedagogy entails. Gagne, et al. (2005) explain that students need to understand and know the SL pedagogy and its objective to be effective. Access to mobile devices, power, and the internet is particularly important. Challenges with access to WiFi and data are echoed by Gillwald and Mothobi (2018), who writes about digital inequality. According to Engstrom and Tinto (2008), a direct correlation can be found between student success and support (a sub-theme that was identified: measurement of success). Sub-themes that set SL apart from other approaches – all readily available, interchangeable and independent of time and place – are alternative teaching and learning approaches, experts' engagement, networking with other students, applying innovative ideas, adjusting measurements of success, improving scholarship opportunities, and challenges.

5.2 Positive Concepts

Another theme that emerged from the data analysis but which is difficult to trace back to the literature is the positive concept of SL. Sub-themes identified as best practices for a positive SL experience included a student-centred approach, real-time interactions with educators and fellow students by receiving immediate feedback, remote access to learning, including a wider globalised experience, practical application of knowledge, extended research opportunities and good preparation for the future. These findings not only contribute to an innovative approach to the SL experience but also contribute to a list of best practices for future implementation. These aspects as a whole are best explained by Vaughan, et al. (2017, p.105), who state that technology-supported learning can improve student access and success: it can "extend access to new populations of students, alleviate the demand on physical infrastructure, and enhance the process of teaching and learning for the diverse body of students". Regarding the real-time interaction mentioned by the participants, the outcome of a study by Owen (2014) indicated that the participants demonstrated high levels of engagement, assessed by increased interaction throughout the programme.

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5.3 Practical Concepts

Abundant literature can be linked to devices, hardware/software, infrastructure, cost and funding, and other sub-themes of practical concepts. These sub-themes highlight that the SL experience would be quite difficult to achieve without these elements. The comments also indicate that not all the students have the same devices, some more sophisticated. Chan, et al. (2006) emphasise that students must have access to one or more personal devices to connect formally or informally, individually or socially, in a context of their choice to support their learning. Wong (2012, p.22) emphasises that a "seamless learner should be able to explore, identify and seize boundless latent opportunities that his daily living spaces may offer to him mediated by technology". This statement is supported by the findings from the data, where the importance of a functional infrastructure was stressed. Access to mobile devices, power, and the internet is essential. De Villiers (2020) mentions costs and funding when mentioning that online education is not a cheap alternative to classroom teaching. Funding devices and data would help to implement SL.

According to Antwi-Boampong (2020) the importance of infrastructure, also pointed out by the participants of this study, is one of the core elements when technology is included in learning. The other three elements are the readiness of the HEIs for change, technical familiarity, and acceptance by and support systems for staff. Regarding policies, Graham, Woodfield and Harrison (2013) emphasise the importance of institutional policies, as they determine the framework within which teaching staff should operationalise blended-learning approaches.

5.4 Human Concepts

An essential theme is the human concept, with the students at its centre – every part of the planning should include the students, if they succeed. Engstrom and Tinto (2008) contend that a direct correlation between student success and support can be found. The student's psychological, physical, and mental capacity needs to be supported by the educator, peers, and the student support office. Kukulska-Hulme, et al. (2021) highlight a trend related to equity-oriented pedagogy. All students should have equal opportunities to benefit from SL and to achieve fair and comparable outcomes, regardless of their backgrounds. As with the theme positive concepts, in previous SL frameworks, human concepts are also not mentioned explicitly as part of best practices.

5.5 Design Concepts

The last theme is design concepts: it embraces sub-themes such as assessment, feasibility, learning strategies, and implementation. Different assessment methods must be explored to complement different methods of learning. Students must be challenged in ways other than formal assessment. Augmented and virtual reality and artificial intelligence tutors and tools that allow virtual interaction can be incorporated. As mentioned in the literature review, the design approach for SL can be based on the ADDIE model (Kurt, 2018), which includes analysing the content, environment and technology, designing and developing the intervention, implementing it and then re-evaluating it. The importance of knowing what the educators have to work with is part of an initial needs analysis before the planning of any design can begin. Once they see the environment's capacity, this knowledge can be used to select the activities and settings. Educators need to keep the goal in mind and focus on improving SL and selecting appropriate activities.

6. Conclusion

In conclusion, this study aimed to answer the research question: "Which concepts constitute a seamless learning experience design framework for students in higher education?" by asking educators from five universities from five countries on five continents to contribute to the investigation. Their views were combined into one dataset. A qualitative approach was followed, and the rich dataset was analysed by an inductive process that included coding and identifying themes from the data. The overall identified concepts for a seamless learning experience design framework include core, positive, practical, human and design concepts. Increasing the sample size by including more educators and more countries and more continents could lead to more comparative analysis opportunities and further validation of the framework.

Compared to existing EdTech learning frameworks as discussed in the literature review these five concepts add additional perspectives to understanding, developing and implementing a seamless learning experience across several environments (physical and virtual) and across various technologies using a combination of relevant pedagogical approaches.

A few suggestions for educators that aim at implementing seamless learning, include the following practical steps:

- decide which core goals to achieve in the course, such as interactive pedagogical approaches and including interview with experts to understand the world of work better.
- select the relevant positive concepts, such as activities that contribute to a positive and engaging experience;
- consider practical concepts such as the availability of technology for the students;
- accommodate human concepts such as the ability and availability of the students;
- ensure that all design concepts, such as "where in the course" and "which assessment will be added", are included.

These five concepts are combined as a Seamless Learning Experience Design (SLED) framework (see Figure 10).

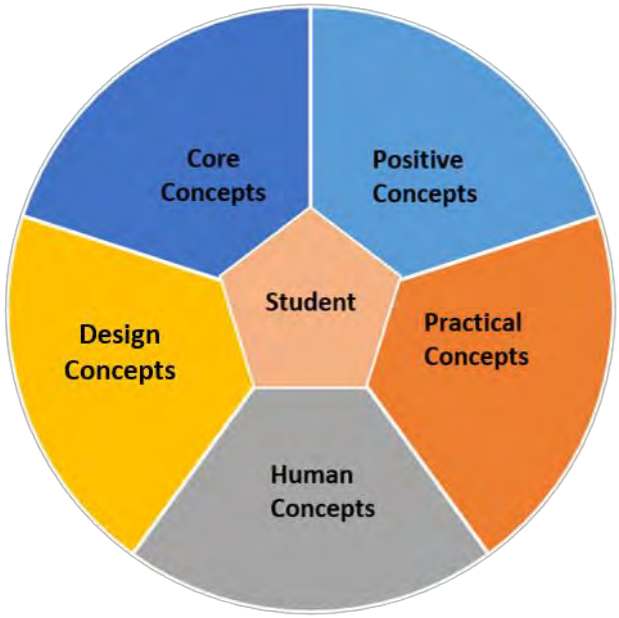

Figure 10: The Seamless learning experience design (SLED) framework

7. Future Recommendations

The SLED framework can be used as a guideline for further research in the field of seamless learning in higher education to find gaps in courses or to design courses from scratch. The SLED framework is also useful for establishing whether a course or program is seamless learning ready or not. It can further be applied for research studies within a department, a university, a country or as a comparative study between countries. Using this framework can contribute to innovatively changing the world of teaching and learning and can be used as an "operational model of activities", as suggested by Bidarra and Rusman (2016). It can also enable students to construct knowledge to engage and inspire them to learn (Olszewski and Crompton, 2020; Milrad, et al., 2013).

To cope with global changes, technological developments and educational advances, educators have to embrace the changes, re-think, re-plan and adjust their practices. Since all these challenges can seem rather daunting and challenging to educators, this study proposes using a seamless learning experience design framework as a valuable tool to focus on the relevant aspects to create a successful, seamless learning experience for our students.

Abbreviations

AI: Artificial intelligence

HEIs: Higher-Education Institutions

IT: Information technology

LMS: Learning management system

MSL: Mobile seamless learning

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SL: Seamless learning

SLED: Seamless learning experience design

VR: Virtual reality

Declarations

Ethics approval and consent to participate

Ethics approval was received from the University of the Free State Ethics Committee, number UFS-HSD2019/0410. Consent for publication was obtained from all the participants.

Consent for publication

The following researchers collected data:

Dr Shamsul Arrieya Ariffin, Tanjong Malim, Perak, Malaysia.

Dr Frelét de Villiers University of the Free State, South Africa.

Dr Helga Hambrock, Concordia University Chicago.

Dr Kathryn MacCallum, University of Canterbury, New Zealand.

Dr Ellen Rusman, Open University of the Netherlands.

They gave their written permission for data use without being co-authors.

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