Employing Design and Development Research (DDR) Approach in Designing Next Generation Learning Spaces (NGLS) In Teachers' Pedagogy and Technology Tools

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Abstract

Design and development research (DDR) is a systematic study of design, development, and assessment processes with the goal of providing an empirical foundation for the production of instructional and non-instructional goods and tools, as well as new or better development models. This method employs a wide range of methods, including qualitative and quantitative techniques, as well as a thorough examination of the literature (Richey & Klein, 2014). The design and development of Next Generation Learning Spaces (NGLS) in instructors' pedagogy and technological tools is described in this article. The effort in generating new perspective in education in developing of the pedagogical framework in teachers' pedagogy and used of technology tools in secondary schools in Malaysia. Therefore, this research paper aims to design and development of NGLS using design and development research (DDR) approach. Researcher will go through three phases of study and use several different study approaches in each phase. In the first phase, researcher was investigated teacher' needs in their pedagogy and technology tools used in their lessons. The phase two and three are to design and development phase which is in real setting by various of expert's consensus in developing the framework as well as evaluate the usability and practicality of the framework. The expert's consensus are the main inputs in developed the framework in context of Malaysian education. Malaysian education has to brings in different paradigms of education and teaching strategies (Don, Raman et al., 2015), which extend to teachers' pedagogy and technology tools impact by NGLS in the future. Therefore, the findings provided useful evidence of potential in designing and development of pedagogical framework in teachers' pedagogy and technology tools.

Introduction

In considering upcoming education trend discipline ,rapid changes and developments in teaching and learning in the world have affected countries, societies and economies, as well as the schools and education systems (Don, Raman et al., 2015). Higher education learning spaces have experienced fast transformation with the introduction of digital natives and incorporation of technology in teaching and learning (Selvaratnam, 2016; Zainuddin, Idrus et al., 2018). Currently, rapid change also increasingly visible in secondary school in between current technology revolution and current learning spaces (Don, Raman et al., 2015; Oblinger, 2005; Oblinger & Lippincott, 2006). The transitions which extend to teachers' pedagogy and technology tools in education system. Next generation education was shaped for the Industrial Age, but classroom environment of tomorrow will be shaped for digital age with NGLS (Arstorp, 2018). The Pedagogy-Space-Technology (PST) paradigm is used to construct Next Generation Learning Environments (NGLS), which allows institutions to create new teaching and learning spaces that will improve student results (Radcliffe, Wilson et al., 2008). NGLS is a positive method to teaching active learning, collaborative, blended, flipped, group work, experimentation, and role acting to a new generation of students (Radcliffe, Wilson et al., 2008). According to The Designing Spaces for Effective Learning study, learning spaces should be able to motivate teaching and encourage learning as an activity, enable collaborative as well as formal practise, offer a customised and inclusive environment, and be adaptable in the face of changing requirements (Jisc, Marmot et al., 2006). Teachers of next generation learners must comprehend the effect of NGLS as a new platform for delivering lessons not just in the traditional classroom, but wherever that technology and space are available. Teachers believe that their classrooms enable them to use a variety of teaching methods, but the opportunities to move from teacher-led to student-directed learning, decrease skilled exposure time, and enhance collaboration are considerably larger.

Nonetheless, when space becomes static and existing learning settings are not intended to maximise learning for the next generation, teachers' pedagogy and teaching style become inactive (Göçen, Eral et al., 2020). Despite the fact that learning environments have an impact on teacher pedagogy, space, and technology. Mulcahy, Cleveland et al. (2015) saw learning environments as being influenced by the instructional instruments and displays used, the architectural environment, and physical interactions inside the space. There are many different ways to define influence of NGLS on pedagogy and technology tools; Sir Ken Robinson warned policy-makers and educators in his February 2010 TED Talk; Bring on the Learning Revolution; that education have to make revolution which is students now living the world with digital. Radical shift from standardised school to personalised learning and teachers as a guide to creating a learning space where students natural talents can flourish. Earlier researcher already seen how mobile technology and ubiquitous technology are a new approach in teaching aids (Abdullah & Siraj, 2010; Leong, Hassan et al., 2018; Pishtari, Rodríguez-Triana et al., 2020). Starting with laptops, tablet computers, and now mobile phones, technology has been given a prominent place in classrooms all around the globe. Touch screen technology and wireless networks, along with the 1 to 1 technology (one student per device) philosophy, have provided students and instructors with new approaches to integrating technology into teaching and learning. Physical learning environments, according to (Byers, Hartnell-Young et al., 2018), impact instructors' pedagogical use of digital technological resources. Malaysia's Education Blueprint 2013-2025 is now in its third phase, which runs from 2020 to 2025 (Avalos, 2011). Malaysian schools have also made the bold step to connect their learning spaces with technological tools in education (Nugraha, Reftyawati et al., 2020).

Next Generation Learning Spaces: Pedagogy-Space-Technology (PST)

The learning environment is made up of three interconnected elements: pedagogy, space, and technology (Fisher, 2005; Oblinger, 2005). The goal of the Pedagogy, Space, and Technology (PST) paradigm is to develop innovative teaching and learning environments that promote positive learning outcomes (Radcliffe, Wilson et al., 2008). Creating a learning environment that encourages students to participate actively is a primary goal of education 5.0 philosophy and, at the same time, a challenge for learning space designers. There are links between pedagogy, technology, and the architecture of a learning environment, and the TPACK framework

demonstrates these relationships (Koehler & Mishra, 2009). Indeed, the ideal future results are produced via the interaction of these three components, pedagogy, space, and technology. In next-generation education, the form and usage of a place will affect the intended pedagogy, while a given technology may influence how a space is utilised by instructors and students. In employment of design and development research in designing the pedagogical framework, researcher was applied the question-driven from the PST framework as a guide in the designing the framework.

The PST framework was used by the researchers to create guidelines for retrofitting learning space in Malaysian teachers' pedagogy and technology tools. The framework was used as the foundation for this research because it provides a straightforward framework for identifying commonalities in what institutions are seeking to achieve, how they do so, and how they measure success (Imms & Kvan, 2021; Radcliffe, Wilson et al., 2008). Researcher need to investigate and analysis this important construct to identified any significant variations in requirement depending on factors is reflected in the design and development of NGLS in teachers' pedagogy and technology tools; to identify potential barriers and issues. The gap showed to researcher to investigated the relationship between pedagogy, space and technology in designing NGLS in teachers' pedagogy and technology tools. Table 1.0 shown the illustrated of the basic questions for the various stages of a new facility. The questions asked within the framework can be tailored to meet particular ways of designing the NGLS framework.

Next generation learners learn more outside the classroom compared inside the classroom (Norazman, Ismail et al., 2019; Ramu, Taib et al., 2020; Zainuddin, Idrus et al., 2018). To get the most out of it, however, pedagogy must be coupled with competence in the design of learning environments and technology (Imms & Kvan, 2021). Teenagers spend two hours each day on average using technology for leisure, mostly for pleasure surfing the Internet and engaging in social networks (Paniagua & Istance, 2018). However, there is no simple transition in technology employed in teachers' pedagogy between informal and widely suggested applications of technology in formal education. If technology is not properly incorporated into the educational environment, it may potentially be harmful to learning. Table 2.0 depicted the educational consequences of using technology in the classroom.

Design and Development Research in Next Generation Learning Spaces (NGLS) Frameworks

The application of design and development research (DDR) methodology is a technique for creating a development study that starts with the requirements analysis phase (Richey & Klein, 2014). It is also used to design and create interventions such as teaching and learning methods and materials, goods and systems, as well as education gaming tools and leadership models, with the goal of solving a complex educational issue (Kragt & Day, 2020; Sahrir, Alias et al., 2012). Van den Akker, Gravemeijer et al. (2006) suggest that researchers should do design research that has been termed "design-based research" (Kelly, 2003), "development research" (Van den Akker, Gravemeijer et al., 2006), "design experiments" (Brown, 1992; Collins, 1992), or "formative research" (Brown, 1992; Collins, 1992; Newman, 1990). The following were the characteristics that defined the DDR in order to answer the research questions:

Table 1

Focus	Conception and Design	Implementation and Operation
Overall	What is the motivation for the initiative?	What does success look like?
Pedagogy	What kind(s) of learning and teaching do we want to encourage? Why?	What type(s) of learning and instruction have you observed? What proof do you have?
Space (Including environs, furniture and fittings)	What elements of the space's design, as well as the furniture and fittings provided, will support these learning and (teaching) models? How?	Which aspects of the space design and equipment worked and which did not? Why?

Technology (ICT, Lab and Specialist equipment)	How will technology be used to support the intended learning and teaching patterns in conjunction with the space design?	What technology proved to be the most successful in terms of improving learning and teaching? Why?

PST framework questions (Radcliffe, Wilson et al., 2008)
Sources: Adapted from (Radcliffe, Wilson et al., 2008)

Table 2

Pedagogical Implications of Technology Use

Advantages		Challenges	
Technology can improve learning outcomes	Technology can improve learning engagement and motivation	Young learners may not be technology savvy.	Technology may reproduce traditional pedagogies
How Pedagogies can Help			
Technology is used in pedagogies as a supplement to instruction rather than as a replacement.	Pedagogies motivate learners "through" technology and not to use technology	Pedagogies promote digital literacy	Teachers have a monopoly on technology; therefore, pedagogies avoid transmission techniques.
Teachers utilise information to modify assistance, while pedagogies offer learners an active role and encourage cooperation.	Pedagogies promote intrinsic motivation and avoid reliance on "novelty"	Pedagogies assess that student have the prior competences to engage with digital environments	Pedagogies pish students toward active strategies in using technology

Source: Adapted from (Paniagua & Istance, 2018)

1. addressing complex problems in real-world contexts in collaboration with practitioners; combining known and hypothetical design principles with technological advances to produce plausible solutions to these complex problems; and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as define new design principles.

The research was basically type 2 design and development research that aims at the design, development and evaluation of a specific framework (Richey & Klein, 2014). The differences between type 1 and types 2 development research are shown in table 3.0.

Table 3

A summary of the 2 types of Development Research

Design and Development Research	
Product and Tool Research	**Model Research**
Comprehensive Design and Development Projects	Model Development
• Instructional Products and Programs	• Comprehensive Model Development
• Non-instructional Products and Programs	• Development of Model Component Processes
Specific Project Phases	Model Validation
• Analysis	• Internal Validation of Model Components
• Design	• External Validation of Model Impact
• Development	
• Evaluation	
Design and Development Tools	Model Use
• Tool Development	• Study of Conditions Impacting Model Use
• Tool Use	• Designer Decision-Making research
	• Designer Expertise & Characteristics research

Sources: Adapted from (Richey & Klein, 2014)

According to Richey and Klein (2014) there were four main comprehensive phases in the DDR research .However, (Abdullah & Siraj, 2010; Mah Tjun Lyn, Cheong et al., 2021; Noh, Siraj et al., 2015) were coordinate the study based on three main phases namely:-

1. Phase one: The need analysis phase (need analysis) is the phase to identify the need for the design and development of NGLS. The aim of this phase is to identify and analyse the need in NGLS.
2. Phase two: The main phase of this study is the design and development phase. In this phase, researcher used learning space framework approach based on Fuzzy Delphi Technique.
3. Third phase (Evaluation): The last phase is the useability phase formed by using the interview method.

Quantitative techniques, qualitative techniques, including case study, interviews, document reviews and observations are in the DDR methodologies. Researcher will use, in-depth interview, literature review, survey and using Fuzzy Delphi technique to analysis the data. The basic framework of the methods used in the DDR based study can be shown in table 4.0 as follows:

Table 4
Design and Development research methods that are often used

Type of Research	Project Emphasis	Research Methods Employed
Product & Tool Research	Comprehensive Design & Development Projects	In-Depth Interview, Case Study, Content Analysis, Evaluation, Field Observation
Product & Tool Research	Phases of Design & Development	Content analysis, expert review, field observation, in-depth interview, and survey product are all examples of case studies.
Product & Tool Research	Tool Development & Use	Expert review, in-depth interview, and survey are all examples of evaluations.
Model Research	Model Development	Case study, Delphi, in-depth interview, literature review, survey, and think-aloud methods are all examples of research methods.
Model Research	Model Validation	Experimental, Expert Review, In-Depth Interview
Model Research	Model use	Case study, content analysis, field observation, in-depth interview, survey, and think-aloud methods are all examples of research methods.

Sources: Adapted from (Richey & Klein, 2014)

In this research study, researcher was adapted Needham Model. The five phases of this model are orientation, generation of idea, restructuring of idea, application of idea, and reflection. Five steps of pedagogy phase to design and development of NGLS in teachers' pedagogy and technology tools in DDR phases. Table 5.0 illustrates the description of Needham Model and modified by researcher to appropriate with research study.

Table 5
Applying Needham Model in Design and Development of NGLS in teachers' pedagogy and technology tools

Phase	Theory and practice
Need Analysis	Orientation
Design and Development	Generation of ideas
	Restructuring of idea
	Application of idea
Evaluation	Reflection

Sources: Adapted from Needham and Hill (1987). Teaching Strategies for Developing Understanding in Science.
Leeds: University of Leeds.

The following is a description of how pragmatic aspects of a design and development (DDR) are used in this paper: -

a) **Orientation**: The design and development of the framework is focus enquiry what teachers need in their learning spaces. To stimulate interest in pedagogy and used of technology tools. At this phase, researcher will be able to identify each research question conducted in the study to design and development of NGLS in teachers 'pedagogy and technology tools (Richey & Klein, 2014). According to McKillip (1987) the needs analysis phase involves the phase of identifying and evaluating the needs of the problems of a target population and solutions available for these problem. Researcher used the Discrepancy Model as a support model in this phase.

b) Generation of Idea: Eliciting ideas which requires that teachers are aware of an alternative framework for their pedagogy and used of technology tools.

c) Restructuring of idea: Combination of expert consensus regarding NGLS as new learning spaces that teachers were used in pedagogy as pedagogic framework.

d) Application of idea: Aims to consolidate correct scientific ideas which have been constructed or to consider daily applications or applications in new situations.

e) Reflection: Helping teachers realize what and how NGLS framework for teachers' pedagogy have been changed during teaching and learning process.

Research Sampling

The participants in this study were instructors, secondary school teachers and experts in the field of learning spaces, technology tools expert, curriculum and pedagogy. Refer to (Tabachnick & Fidell, 2013), when designing a study, an adequate sample size or more precise sample strength should be a major concern (Kyriazos, 2018). In this study, (Kline, 2016), respondents in need analysis phase are 280 secondary school teachers using purposive sampling. The most important phase in DDR approach is phase 2; design and development. The main focus of this phase is to design and development of NGLS in teachers' pedagogy and technology tools. Further discussion will be discussed specifically and in detail on sampling and population, instrumentation, process analysis, data processing and design and development of NGLS. If there is a high degree of consistency among experts, the optimal number of experts in the Delphi method, according to Adler and Ziglio (1996), is between 10 and 15. According to Jones and Twiss (1978), there may be anywhere from 10 to 50 experts (Lynne, Barr et al., 2016). Curriculum experts, specialised university lecturers, lecturers at teacher training institutions, technology experts, and learning spaces specialists will all be included in this research project. Evaluation phase is the last phase in DDR approach. According to (Richey & Klein, 2014) this phase aims to looked forward at suitability as well as useability of NGLS in teachers' pedagogy and technology tools. In this phase, researcher used 2 teachers as a sample; which is user of the learning spaces such as makerspace, active learning spaces and involved technology in their pedagogy. According (Creswell & Poth, 2007), the number of sample ranging from 1 or 2 to 30 or 40 . Furthermore, gathering qualitative data and analysing it takes time, and adding additional person or location just adds to that time (Creswell & Poth, 2007). The overview of design and development research for each step is shown in Table 6.0.

Table 6
Summary of design and development research accordingly to the phase

Research Phase	Instruments	Data Analysis	Expected outcomes
Phase one: Need Analysis Phase	Quantitative: Survey	Data analysis are using *Statistical Package for Social Science* (SPSS) Version 27.0. Interpretation mean analysis were used to determine the teachers need in NGLS	Finding shows teachers needs in NGLS framework in their pedagogy

			related with pedagogy and technology tools.
Phase two: Design and Development	*Fuzzy Delphi Method (FDM)* FDM 1-Main Constructs FDM 2- Elements in main constructs.	Threshold (d) ≤0.2 Experts' consensus percentage ≥ 75% and a-cut ≥ 0.5	Design and development prototypes of NGLS framework in teachers; pedagogy and technology tools.
Phase three: Evaluation Phase	Semi-Structured interview	Researcher will collect the data through interviewing participants and convert or transcribe data collection turn recorded talk into text (software program- e.g, Dragon NaturallySpeaking found at nuance.com)	Final framework from the Fuzzy Delphi analysis based on expert consensus view.

Discussion

The extensive review that was conducted presented strong evidences that NGLS have impact on teachers' pedagogy and technology tools. Researcher and practitioners from wide range of discipline; maintain that learning space as "third teacher" that can enhanced students potential to response creatively and meaningfully to next generation learning challenge (Fraser, 2014; Guven, 2009). This is revealing the need of new pedagogical framework that teachers are able to embedded learning spaces, technology tools and teachers' pedagogy in new generation of leaners. According to the findings, the majority of the teachers feel comfortable with flexible learning spaces which is a space for collaboration work, project work and individual works. Majority of the respondents have learned through reasonable years of experience and the finding showed the need of transition in learning spaces. Students need to enjoy group discussions, working in collaborative and interactive environments using digital learning tools such as connect their academic world with iPad, laptop, tablet, smartphone and smartwatch (Nambiar, Nor et al., 2018). There are understanding of learning spaces reflects the contexts for next generation learners (Campbell, 2020)'; attributed the use of spaces, influences by pedagogy, innovative learning with digital technology, aligns with the physical space. In NGLS, pedagogy impact the student-centered learning with students taking an active role in the learning process rather than being inactive leaners and passive recipients of information from the teachers (RAO, 2020). Teachers' pedagogy was addressed using technology tools in NGLS as they transitioned from traditional to blended learning. Virtual learning in NGLS requires the use of learning technologies such as ZOOM Cloud Meeting and Google Drive. In virtual learning, several teaching and learning modalities such as social media (Facebook, WhatsApp, Telegram), pre-recorded lecture videos (YouTube), and live video conferences (Zoom, Microsoft Teams) were used (Kamal, Shaipullah et al., 2020). In NGLS, Google Classroom has a lot of potential to help instructors with their teaching. Teachers were expected to actively participate in an online pedagogy and improved teaching methods in order to build their expertise. In omnipresent learning environments, pedagogy took place at any time and in any place (Abidin & Saputro, 2020).

Conclusion

Finally, the use of the Design and Development method in developing the NGLS framework in teachers' pedagogy and technological tools is intended to educate policymakers about future classroom settings that instructors want or foresee in accordance with 21st century capabilities. Teachers will be more conscious of using NGLS as new teaching and learning environments, as well as technological tools in their pedagogies, as a result of the findings of this study. This research looks at the three main elements of the PST framework. The researcher highlighted the necessity for NGLS in instructors' pedagogy and technological tools using the PST framework as a reference. To improve pedagogy among next generation learners, teachers need a pedagogical framework that integrates technology and learning environments.

References

Abdullah, M. R. T. L., & Siraj, S. (2010). M-Learning Curriculum Design for Secondary School: A Needs Analysis. *International Journal of Educational and Pedagogical Sciences, 4*(6), 1371-1376. Doi:https://doi.org/10.5281/zenodo.1075645

Abidin, Z., & Saputro, T. (2020). *Google classroom as a mathematics learning space: potentials and challenges.* Paper presented at the Journal of Physics: Conference Series. Doi:https://doi.org/10.1088/1742-6596/1567/2/022094

Adler, M., & Ziglio, E. (1996). *Gazing Into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health*: Jessica Kingsley Publishers. Retrieved from https://books.google.com.pk/books?id=jo1Z1JZIrKlC

Arstorp, A.-T. (2018). *Future classroom labs in Norwegian pre-service teacher education.* Paper presented at the International Conference on Innovative Technologies and Learning. Doi:https://doi.org/10.1007/978-3-319-99737-7_30

Avalos, B. (2011). Teacher professional development in Teaching and Teacher Education over ten years. *Teaching and Teacher Education, 27*(1), 10-20. Doi:https://doi.org/10.1016/j.tate.2010.08.007

Brown. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences, 2*(2), 141-178. Doi:https://doi.org/10.1207/s15327809jls0202_2

Byers, T., Hartnell-Young, E., & Imms, W. (2018). Empirical evaluation of different classroom spaces on students' perceptions of the use and effectiveness of 1-to-1 technology. *British Journal of Educational Technology, 49*(1), 153-164. Doi:https://doi.org/10.1111/bjet.12518

Campbell, L. (2020). Teaching in an Inspiring Learning Space: an investigation of the extent to which one school's innovative learning environment has impacted on teachers' pedagogy and practice. *Research Papers in Education, 35*(2), 185-204. Doi:https://doi.org/10.1080/02671522.2019.1568526

Collins, A. (1992). Toward a design science of education. In *New directions in educational technology* (pp. 15-22): Springer. Doi:https://doi.org/10.1007/978-3-642-77750-9_2

Creswell, J. W., & Poth, C. N. (2007). Qualitative inquiry and research method: Choosing among five approaches. In: Thousand Oaks, CA: Sage.

Don, Y., Raman, A., Daud, Y., Kasim, K., & Omar Fauzee, M. S. (2015). Educational leadership competencies and Malaysia education development plan 2013-2025. *Humanities and Social Sciences Review, 4*(3), 615-625. Retrieved from http://repo.uum.edu.my/id/eprint/19470

Fisher, K. (2005). Linking pedagogy and space. *Victoria University Australia: Department of Education and Training [Victoria].* Retrieved from https://www.education.vic.gov.au/Documents/school/teachers/teachingresources/interdisciplinary/ict/pedagspace.pdf

Fraser, K. (2014). The Future of Learning and Teaching in Next Generation Learning Spaces. International Perspectives on Higher Education Research. Volume 12. In *International Perspectives on Higher Education Research*. Doi:https://doi.org/10.1108/S1479-3628201412

Göçen, A., Eral, S. H., & Bücük, M. H. (2020). Teacher perceptions of a 21st century classroom. *International Journal of Contemporary Educational Research, 7*(1), 85-98. Doi:https://doi.org/10.33200/ijcer.638110

Guven, U. (2009). The influence of the Hosford exponent on the critical major strain of a sheet metal. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 223*(4), 409-412. Doi:https://doi.org/10.1243/09544054JEM1403

Imms, W., & Kvan, T. (2021). *Teacher Transition Into Innovative Learning Environments: A Global Perspective*: Springer Nature. Doi:https://doi.org/10.1007/978-981-15-7497-9

Jisc, Marmot, A., & Ama. (2006). *21st Century Learning Space Design.* Doi:http://dx.doi.org/10.13140/RG.2.2.22776.24321

Jones, H., & Twiss, B. C. (1978). *Forecasting technology for planning decisions.* Retrieved from http://www.sidalc.net/cgi-bin/wxis.exe/?IsisScript=UACHBC.xis&method=post&formato=2&cantidad=1&expresion=mfn=022535

Kamal, A. A., Shaipullah, N. M., Truna, L., Sabri, M., & Junaini, S. N. (2020). Transitioning to online learning during COVID-19 Pandemic: Case study of a Pre-University Centre in Malaysia.

International Journal of Advanced Computer Science and Applications, 11(6), 217-223. Doi:https://dx.doi.org/10.14569/IJACSA.2020.0110628

Kelly, A. E. (2003). Theme Issue: The Role of Design in Educational Research. *Educational researcher, 32*(1), 3-4. Doi:https://doi.org/10.3102%2F0013189X032001003

Kline, D. M. S. (2016). Can restorative practices help to reduce disparities in school discipline data? A review of the literature. *Multicultural Perspectives, 18*(2), 97-102. Doi:https://doi.org/10.1080/15210960.2016.1159099

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary issues in technology and teacher education, 9*(1), 60-70. Retrieved from https://www.learntechlib.org/primary/p/29544/

Kragt, D., & Day, D. V. (2020). Predicting leadership competency development and promotion among high-potential executives: The role of leader identity. *Frontiers in psychology, 11*, 1816. Doi:https://doi.org/10.3389/fpsyg.2020.01816

Kyriazos, T. A. (2018). Applied psychometrics: sample size and sample power considerations in factor analysis (EFA, CFA) and SEM in general. *Psychology, 9*(08), 2207-2230. Doi:https://doi.org/10.4236/psych.2018.98126

Leong, L. C., Hassan, N., Isa, F. M., & Ab Jalil, H. (2018). Mobile x-space design, teaching strategies and undergraduate students' collaborative learning behaviour: a case study in Taylor's University, Malaysia. *Malaysian Journal of Learning and Instruction, 15*(2), 175-205. Doi:https://doi.org/10.32890/mjli2018.15.2.7

Lynne, T., Barr, J., & Meghnagi, M. (2016). Boosting Job Creation in Skive, Denmark. *OECD Local Economic and Employment Development (LEED) Papers 2016/01*. Doi:https://doi.org/10.1787/5jm3stcjvfln-en

Mah Tjun Lyn, J., Cheong, L. S., & Binti Rosli, N. A. (2021). Defining the roles and responsibilities of Malaysian primary school educators in supporting the Pre-Transition Stage of inclusive transitions: a Fuzzy Delphi method. *International Journal of Inclusive Education*, 1-17. Doi:https://doi.org/10.1080/13603116.2021.1942567

McKillip, J. (1987). Need Analysis. In. Thousand Oaks, California: SAGE Publications, Inc. Doi:https://dx.doi.org/10.4135/9781412985260.n2

Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: Envisioned, enacted and experienced. *Pedagogy, Culture & Society, 23*(4), 575-595. Doi:https://doi.org/10.1080/14681366.2015.1055128

Nambiar, R. M., Nor, N. M., & Ismail, K. (2018). *THE IMPACT OF NEW LEARNING SPACES ON TEACHER PEDAGOGY AND STUDENT LEARNING BEHAVIOR*. Paper presented at the 12th International Technology, Education and Development Conference. Doi:http://dx.doi.org/10.21125/inted.2018.1969

Needham, R., & Hill, P. (1987). *Teaching Strategies for Developing Understanding in Science. Children's Learning in Science Project*. Retrieved from http://hdl.handle.net/10068/458924

Newman, D. (1990). Opportunities for research on the organizational impact of school computers. *Educational researcher, 19*(3), 8-13. Doi:https://doi.org/10.3102%2F0013189X019003008

Noh, N. M., Siraj, S., Jamil, M. R. M., Husin, Z., & Sapar, A. A. (2015). Design of Guidelines on the Learning Psychology in the Use of Facebook as a Medium for Teaching & Learning in Secondary School. *Turkish Online Journal of Educational Technology-TOJET, 14*(1), 39-44. Retrieved from https://eric.ed.gov/?id=EJ1057337

Norazman, N., Ismail, A. H., Ja'afar, N. H., Khoiry, M. A., & Ani, A. I. C. (2019). A review of seating arrangements towards the 21st century classroom approach in schools. *Malaysian Journal of Sustainable Environment, 6*(2), 21-46. Doi:https://doi.org/10.24191/myse.v6i2.8684

Nugraha, D., Reftyawati, D., & Sari, Y. A. (2020). The Effective School Strategic Plan Implementation: A Best Practice of School Improvement. *Attractive: Innovative Education Journal, 2*(2), 9-19. Doi:http://dx.doi.org/10.51278/aj.v2i2.44

Oblinger, D. (2005). Leading the Transition from Classrooms to Learning Spaces. *Educause Quarterly, 28*(1), 14-18. Retrieved from https://www.educause.edu/ir/library/pdf/eqm0512.pdf

Oblinger, D., & Lippincott, J. K. (2006). *Learning spaces*: Boulder, Colo,.: EDUCAUSE, c2006. 1 v.(various pagings): illustrations. Retrieved from https://www.iicseonline.org/psychology_of_learning_1.pdf

Paniagua, A., & Istance, D. (2018). *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies. Educational Research and Innovation*: OECD Publishing. Doi:http://dx.doi.org/10.1787/9789264085374-en

Pishtari, G., Rodríguez-Triana, M. J., Sarmiento-Márquez, E. M., Pérez-Sanagustín, M., Ruiz-Calleja, A., Santos, P., . . . Väljataga, T. (2020). Learning design and learning analytics in mobile and ubiquitous learning: A systematic review. *British Journal of Educational Technology, 51*(4), 1078-1100. Doi:https://doi.org/10.1111/bjet.12944

Radcliffe, D., Wilson, H., Powell, D., & Tibbetts, B. (2008). Designing next generation places of learning: Collaboration at the pedagogy-space-technology nexus. *The University of Queensland, 1,* 6-20. Retrieved from https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.215.788&rep=rep1&type=pdf

Ramu, V., Taib, N., & Aziz, N. F. (2020). THE ATTRIBUTES OF FUTURE SOCIAL LEARNING BUILT ENVIRONMENTS TOWARDS 21st CENTURY EDUCATION IN TERTIARY EDUCATION. *PLANNING MALAYSIA, 18*(13), 326-337. Doi:http://dx.doi.org/10.21837/pm.v18i13.796

RAO, K. A. (2020). ROLE OF TEACHER IN STUDENT CENTERED LEARNING METHOD. *Research Journal of English Language and Literature (RJELAL), 8*(1), 55-58. Retrieved from http://www.rjelal.com/8.S1.2020/55-58.pdf

Richey, R. C., & Klein, J. D. (2014). Design and development research. In *Handbook of research on educational communications and technology* (pp. 141-150): Springer. Doi:https://doi.org/10.1007/978-1-4614-3185-5_12

Sahrir, M. S., Alias, N. A., Ismail, Z., & Osman, N. (2012). Employing Design and Development Research (DDR): Approaches in the Design and Development of Online Arabic Vocabulary Learning Games Prototype. *Turkish Online Journal of Educational Technology-TOJET, 11*(2), 108-119. Retrieved from https://files.eric.ed.gov/fulltext/EJ989018.pdf

Selvaratnam, V. (2016). Malaysia's higher education and quest for developed nation status by 2020. In *Southeast Asian Affairs 2016* (pp. 199-222): ISEAS Publishing. Doi:https://doi.org/10.1355/9789814695671-016

Tabachnick, B. G., & Fidell, L. S. (2013). Using multivariate statistics: International edition. *Pearson*.

Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (2006). *Educational Design Research*: Taylor & Francis. Retrieved from https://books.google.com.pk/books?id=CMR8AgAAQBAJ

Zainuddin, N., Idrus, R. M., & Mohmaed, A. F. (2018). Designing learning spaces for effective learning. *Maldives National Journal of Research,* 6(1), 7-18. Retrieved from http://saruna.mnu.edu.mv/jspui/handle/123456789/4290