

Evaluation of Packet Tracer Application Effectiveness in Computer Design Networking Subject

Ambiyar^{#1}, Surfa Yondri^{*}, Dedi Irfan[#], Meilani Utami Putri[#], Mahesi Agni Zaus[#], Syaiful Islami[#]

[#]Technical and Vocational Education, Universitas Negeri Padang, Jl. Prof. Dr. Hamka Padang, Indonesia
E-mail: ¹ambiyar@ft.unp.ac.id

^{*}Department of Electrical Engineering, Politeknik Negeri Padang, Indonesia
E-mail: surfa_yondri@yahoo.com

Abstract— The dynamics of technological progress in various fields indirectly affect the world of education. One of the indications can be seen in the use of media as a learning tool. This study aims; 1) to investigate the effectiveness of the packet tracer learning media application, 2) to investigate the responses of the students to such applications, 3) to determine the appropriate media used in a learning process. The research is carried out in the subject of Computer Design Networking. The evaluation research is employed by using a mixed method of qualitative and quantitative approach. The quantitative analysis involved 58 students, while the qualitative analysis involved one productive teacher, one curriculum representative, and four students. Data are analysed by using quantitative and qualitative data analysis techniques. The results show that, the effectiveness of learning media with packet tracer is high i.e., 82.76%, which covers three aspects; software engineering, learning aspects, and display aspects. This means that this packet tracer learning media can be applied as a solution to the limitation of facilities and infrastructures of network practices by considering certain learning situations and conditions. The results indicate that this application is very useful to deal with the high cost of practising tools. It makes the students more enthusiastic and motivated during the learning process. Hence, by implementing this learning method, the interaction and the learning outcomes of the student can be increased.

Keywords— evaluation; packet tracer; effectiveness; learning media; computer networking.

I. INTRODUCTION

Learning is a system consisting of various components. Media is one of the learning components. Learning media is anything that concerns hardware (concepts and contexts) and software (technologies) [1], [2]. Media can be used to convey the content of instructional materials from learning resources to learners (individuals or groups), which can stimulate thoughts, feelings, concerns, and interest of learners in such a way that the learning process (inside/outside the classroom) becomes more effective [3].

Changes and technological advances in various fields, for example in communication and information technology at this time, learning media has a central position in the learning process and not solely as a tool. In such a position, well designed and effectively designed instructional media will make learning exciting and useful [4] and can improve the quality of education [5], [6].

Initial observation on the field Computer design Networking (CDN) interviews with the teachers in Vocational High School No. 1 in Painan West Sumatera, Indonesia. In this school, the CDN learning process still

uses conventional methods of practice. Usually, the teacher gives a worksheet containing material and exercises in the early stages of the teacher explaining the basic functions already in the material. Then proceed with practice by the existing exercise. In doing so many obstacles encountered include: (a) The limitations of network devices so students have to take turns in group practice causing some students not to participate, (b) The high price of network devices are needed for practice, and (c) The practice process should take considerable time, because students must physically configure the network, in addition to the minimal amount of practice equipment.

Many obstacles faced by students when practice, thus causing students to participate less and interact in learning. Teachers can use learning media to overcome the problems experienced by students. The Flow chart-based Intelligent Tutoring System (FITS) is a medium that utilizes the Bayesian network has been proven to effectively increase the different levels of knowledge for students [7]. The result of FITS media evaluation can increase students' learning interest, attitude and level of technology acceptance and achievement in problem-solving [8]. Teachers at Vocational

high school No. 1 in Painan using packet tracer media in the process of CDN learning. The research shows that packet tracer media can help in the learning process [9]. Murtado, et al. used quantitative research methods and Integrated Theory of Acceptance and Use of Technology (UTAUT), while this research uses the development of Multimedia Evaluation, Pedagogy and Interactive Software (EMPI) [10], and the Learning Object Review Instrument (LORI) [11] which simplified into 3 aspects.

Packet Tracer is a comprehensive learning software application for teaching skills and concepts related to computer networks. Packet Tracer is a software developed by Cisco. The software has usability to make computer network simulation or often called by the computer network. Packet tracer software makes learning more comfortable by providing realistic network simulation and visualization of the environment [12]. Also, this packet tracer software can simulate the continuous real-time updates that underline the logic and network activities.

Packet Tracer's primary goal is to provide learning aids for students and teachers to understand the principles of computer networks and also build skills in the field of Cisco networking tools. The functionality of the network devices in the tracer package almost resembles the original device function. The existence of packet tracer is expected to help improving learning outcomes and student interaction in learning, so that students or the school are no longer worried about the lack of practice facilities because the application-based media almost has a function as the original form, so that each student can practice alone without having to wait to change the use of the tool with his friend.

Another component of learning is an evaluation. Evaluation is an integral part of the whole process of using instructional media. Evaluation is a step that must be passed or done. Evaluation is the process of determining the suitability of learning and learning. Evaluation of instructional media is a process or activity to determine the suitability of learning [13], [14], and know about effectiveness and efficiency of media that is used in the teaching-learning process can reach the purpose which has been determined. The evaluation includes not only effectiveness and efficiency but also accessibility, impact, relevance, and sustainability [15].

This research aims that are: (1) to expose the effectiveness of the application of packet tracer learning media to the subjects of Network Design; (2) to know the student's response to the application of packet tracer learning media; (3) determine the appropriate media that is used in the learning process in the classroom.

II. MATERIAL AND METHOD

The method that used is the method of evaluation with a quantitative and qualitative approach (mixed method). Mixed method research is a combination research method that uses approaches in research by combining or linking between quantitative and qualitative research methods [16]. A combination method of quantitative and qualitative or mixed models (concurrent triangulation) is a method of research. By mixing both methods in a balanced way so that researchers can compare all data that are obtained from both methods to conclude [17]

This research was conducted in Public vocational high school No. 1 in Painan, West Sumatera Indonesia. The respondents of the quantitative approach are 58 students of Grade XI in Computer Networking Technique subject, and respondents for qualitative approach covering are one teacher, vice curriculum, and 4 students. Quantitative data collection techniques in this study used the questionnaire. Questionnaires were prepared using Likert scales with five option from *Strongly Agree* to *Disagree Strongly*. Aspects evaluated include aspects of software engineering, learning, and communication. Questionnaire before being used for data collection is validated by an expert (expert judgment). Four experts validate the questionnaire. After the expert validated the questionnaire, a try out was conducted. Analysis of the questionnaire test with the help of SPSS program version 20 obtained 25 results of the declared valid and reliability coefficient of 0.862.

The technique of collecting qualitative data is done by interview, observation and study documentation [18]–[20]. Test the validity of qualitative data called credibility, the term used in qualitative research to replace the concept of validity on quantitative data. Data credibility can be maintained by using several criteria of examination techniques, namely: 1) extension of the researcher's participation in the field, 2) increasing observational persistence, 3) triangulation [21]. The quantitative data is analyzed by descriptive statistics, while qualitative data with reduction, display, and conclusions [22].

III. RESULT AND DISCUSSION

This section describes the data and the achievement level of each research evaluation component toward effectiveness of packet tracer instructional media implementation on Design of Network subject Grade XI in the subject of computer networking technique at Public vocational high school No. 1 in Painan, West Sumatera Indonesia consisting of three aspects namely aspects of software engineering, learning and display aspects.

A. Quantitative Data Description

1) *Aspects of Software Engineering*. Software engineering aspects are divided into four indicators: technical quality, interaction usefulness usability interaction, and accessibility. Table 1 shows the Level of Respondent Achievement (LRA) of each item from the aspect of software engineering.

In table 1, the technical quality indicator consists of 2 items. Average score of 3.41 and LRA 85.34%. So it can be concluded that the technical quality indicators obtained the achievement level of respondents with the high category. Furthermore, the interaction usability indicator consists of 2 items. The results of data analysis for this indicator obtained an average score of 3.26 with LRA 81.47%. So it can be concluded that the indicator of interaction usability obtained the achievement level of respondents with a high category. Next, the accessibility indicator consists of 2 items, with an average score of 3.32 and LRA 83.19%. So it can be concluded that accessibility indicator obtains the achievement level of the respondent with a high category. Then, usability indicators consist of 4 items. The result of data analysis obtained an average score 3.35 with LRA

83.76%. Means usability indicator obtains LRA with a high category. Overall for the indicator of software engineering aspects, the results of data analysis obtained the achievement level of respondents 88.32 with a high category.

TABLE I
RECAPITULATION OF RESPONDENTS ACHIEVEMENT LEVEL OF SOFTWARE ENGINEERING ASPECT

Indicator	Item	Average	LRA (%)	Categories
Technical Quality	Packet tracer media has provided service to many users (users)	3.33	83.19	High
	Packet tracer media has good stability moment	3.50	87.50	High
Interaction Usefulness	Packet tracer media is conveniently used in the process	3.21	80.17	High
	Packet tracer media is very user-friendly and not confusing inside	3.31	82.76	High
Accessibility	Packet tracer media is easy to run in various software and hardware	3.12	78.02	Medium
	Application opening speed of Packet tracer media is fast	3.53	88.36	High
Usability	Packet tracer media is easy to be used by students from a background of that different ability	3.28	81.90	High
	Packet tracer media is easy to be used in the process of learning independently	3.29	82.33	High
	Packet tracer media is easy to be used in the group learning process.	3.34	83.62	High
	Packet tracer media is comfortable in operating it.	3.41	85.34	High
Total Percentage Aspects of Software Engineering			83,32	High

2) *Aspects of Learning*. The learning aspect is divided into three indicators: material suitability, instructional design, and language usage. Table 2 shows the level of respondent achievement of each item from the aspect of learning.

In table 2, the material conformity indicator consists of 3 items. Based on data analysis, the result of the average score is 3.40 and LRA 85.34%. So it can be concluded that material conformity indicator obtains the achievement level of respondents with the high category. Furthermore, learning the design indicator consists of 3 items. The results of data analysis for this indicator obtained an average score of 2.95 with LRA 73.71%. So it can be concluded that the learning design indicator obtained the achievement level of respondents with a medium category. Next, the language usage indicators consist of 2 items, with an average score of 3.29 and the achievement level of respondents 82.11%. So it can be concluded that language usage indicators obtain the

achievement level of respondents with a high category. Overall for the indicator of software engineering aspects, the results of data analysis obtained the achievement level of respondents 80.69 respondents with the high category.

TABLE II
RECAPITULATION OF RESPONDENTS ACHIEVEMENT LEVEL OF LEARNING ASPECT

Indicator	Item	Average	LRA (%)	Categories
Material Compatibility	Application of packet tracer media is compatible with network design material	3.45	86.21	High
	Design materials the network can be practiced with packet tracer applications	3.24	81.03	High
	Conformity of material in packet tracer media with the competencies achieved by students	3.52	87.93	High
Learning Design	Packet tracer media facilitate students in learning design networking	2.90	72.41	Medium
	Packet tracer media can improve students' motivation in network design learning	3.02	75.43	Medium
	The material in packet tracer media is accompanied by illustrations of images to make it easier for students to understand	2.93	73.28	Medium
Language Usage	Packet tracer media use clear terms	3.53	88.36	High
	Packet tracer media use the terms that are easy to understand	3.28	81.90	High
	Terms used in packet tracer is by the rules of the language	3.29	82.33	High
Total Percentage of Design Learning Aspect			80.69	High

3) *Display Aspect*. Aspects of the display are divided into three indicators namely multimedia documents, navigation, and media design. Table 3 shows the level of respondent achievement of each item from the display aspect.

In table 3, the multimedia document indicator consists of one item. Based on the data analysis, the result of the average score is 3.34, the achievement level of respondents 83.62%. So it can be concluded that multimedia document indicator obtained the achievement level of respondents with the high category. Furthermore, the navigation indicator consists of 2 items. The results of data analysis for this indicator obtained an average score of 3.52 with the achievement level of respondents 88.14%. So it can be concluded that the navigation indicator obtained the achievement level of respondents with a medium category. Next, media design indicators consist of 3 items, with an average score of 3.25 and the achievement level of respondents 80.89%. So it can be concluded that the media

design indicators obtain the achievement level of respondents with a high category. The achievement level of

respondents overall indicator of the display is equal to 84.29% with a high category.

TABLE III
RECAPITULATION OF RESPONDENT ACHIEVEMENT LEVEL DISPLAY ASPECT

Indicator	Item	Average	LRA (%)	Categories
Multimedia Document	It has a help menu that can help students	3.34	83.62	High
Navigation	Navigate in packet tracer media makes it easy to operate.	3.41	85.34	Medium
	Navigation buttons are consistent across packet tracer applications	3.64	90.95	Very high
Design Media	It has a layout design interesting	3.24	81.03	High
	It has a neat look	3.53	88.36	High
	Menu position on the packet tracer media is easy to remember by students	2.93	73.28	Medium
Total Percentage of Display Aspect			84.29	High

B. Qualitative Data Description

In addition to collecting data through questionnaires, researchers also conducted interviews, observations and documentation studies to support and complement the quantitative data evaluating the effectiveness of instructional media of packet tracer application on the design subjects of Grade XI at in Public vocational high school No, 1 in Painan, West Sumatera Indonesia. Interviews that researchers do related to aspects of software engineering, aspects of learning and display aspects.

The results of interviews data collection with six informants, after doing data reduction, removing

unnecessary, or selecting each data relevant to the focus of the problem under study can be seen in appendix 23. After that, the data are presented and taken conclusions. The results of the data display and conclusions from interview results are as follows:

1) *Aspects of Software Engineering*. Associated with the aspect of software, qualitative data is obtained from interviews with RBJ subject teachers and 2 students XI TKJ 1 and 2 students XI TKJ 2. Table 4 presents the results of interviews with the software engineering aspect.

TABLE IV
RESULTS OF INTERVIEWING ASPECTS OF SOFTWARE ENGINEERING

Date and time	Initial name interviewed	Interview result
Monday/ 10 July 2017	NE	When viewed from the aspect of software engineering is very good because this media has an exciting design. The procedure for using and how to configure the network almost resembles the original. This media very support in the learning process to learning achievement.
Tuesday/ 11 July 2017	RMA	Good, easy to use, the download is not difficult to be used in all operating systems.
Tuesday/ 11 July 2017	MI	Its application is very good because the application is easy to be used, useful, the application is not easy to error.
Wednesday /12 July 2017	HAM	Good design and function of the application are beneficial for students.
Wednesday/ 12 July 2017	WKP	In terms of software greatly useful and students who do not like network learning can love it because of the ease given by the packet tracer application

The interview results in table 4 can be concluded that: a) The procedure for using and how to configure the network almost resembles the original, b) The using is comfortable, c) packet tracer is useful and not be easy to error, d) application

of packet tracer make it easy for so many students that love it.

2) *Aspects of Learning*. Associated with the learning aspect, qualitative data obtained from the interview with the vice principal of the curriculum field, CDN subject teachers and 2 students of grade XI. Table 5 presented the results of interviews of the learning aspect.

TABLE V
INTERVIEW RESULT ASPECTS OF LEARNING

Date and Time	Initial Name Interviewed	Interview result
Monday/ July 10, 2017	N	Media is essential inside the process of learning because the media makes students more interested in paying attention to the lesson to encourage the creation of learning processes in students. Also, this media can also be used as a teacher in self-learning besides the facilities and learning infrastructure is still not fulfilled because of the number of majors and the number of students in SMKN 1 Painan so that students still have to turn laboratory and tool at during practice learning.
Monday / July 10 ,2017	NE	Viewed from the aspect of learning very helpful in the learning process teachers can practice how to configure the network although not in the real form. At least with the media can give an idea to students how to configure the network.
Tuesday/ July 10, 2017	RMA	With the application of packet tracer, students can practice themselves at home and school. Yes, with it stimulating learning media interest in student learning so that learning interaction emerges
Tuesday July 10, 2017	MI	From a very learning point petrified because with this application we can learn about the network and provided network devices vary. However, a little problem is in the language because it uses English
Wednesday July 12, 2017	HAM	Easy if studied seriously then our learning results will increase.
Wednesday July 12, 2017	WKP	Yes, packet tracer already provides enhancement to student learning interaction and network material can be practiced by using this app.

The interview results in table 5 can be concluded that: a) instructional media is very important in learning process, b) facilities and infrastructures are still inadequate, c) with

packet tracer application able to give description to students how to network configuration d) stimulate students' interesting in learning so that learning interactions arise, e) In terms of learning is very petrified but little problem that is in the language because it uses English, f) easy to learn seriously.

3) *Display Aspect*. Associated with the aspect of the display, qualitative data obtained from interviews with vice curriculum, CDN subject teachers and 2 students XI Computer network technique (CNT) 1 and 2 students XI CNT 2. Table 6 presents the results of interviews of the display aspect.

TABLE VI
INTERVIEW RESULT DISPLAY ASPECT

Date and Time	Initial Name Interviewed	Interview result
Monday/ July 10, 2017	NE	In terms of looking very interesting because the tools provided are designed to resemble the original form. Moreover, all the menus and navigation buttons have consistent functionality
Tuesday/ July 11, 2017	RMA	It looks exciting, nice color blend and easy layout to remember
Tuesday/ July 11, 2017	MI	It looks very nice and exciting to make students happy to learn
Tuesday / July 12, 2017	HAM	Yes, the look of the packet app tracer is fascinating though the menu functions very much
Tuesday/ July 12, 2017	WKP	It looks interesting however too many menus, and icons are provided so often confuse the user

The interview result in table 6 can be concluded that: a) in terms of appearance is very interesting, b) all menus, icons, and navigation buttons have consistent functions, c) it looks good to make students happy in learning, d) many menu and icons provided so often cause confusion for the user.

C. Discussion

From the analysis of quantitative data for each aspect, on the aspect of software engineering is in the high category of 83.32%. Aspects of learning are in the high category of 80.69%, and the display aspect is in the high category of 84.29%. Moreover, the results of the overall of the three aspects are equal to 82.76% who entered into the high category. This is also supported by qualitative results of interviews, observations and documentation studies. Indicators in this study are software engineering, learning aspects, and display aspects. From the analysis of qualitative data can be concluded that the packet tracer media is very supportive for teachers and students in the learning process because of the expensive tools of students TKJ practice if the school must meet all the needs of teachers and students. Also, with the application of packet tracer media students are more passionate and motivated in learning to improve student interaction and learning outcomes.

In choosing the media, need to be adjusted with situation and condition. The selection of instructional media should be attention to the following criteria: a) the ability to accommodate the presentation of appropriate stimuli (visual and/or audio), b) ability to accommodate appropriate student responses (written, and/or physical activity), c) ability to accommodate feedback, d) selection of mainstream and secondary media for presentation and tests (e) institutions, teachers, and learners) and cost-effectiveness [23]. The media chosen for use in learning can attract students' interest, attention, thought, and feelings so that the learning objectives are achieved [24].

From the description above and the results of the qualitative and quantitative analysis can be concluded that the effectiveness of the use of learning media with packet tracer is in the high category of 82.76% means that the effective learning media is applied in network design learning after reviewing of 3 aspects of the quality of learning media. Moreover, supported by the results of interviews with some informants who concluded a) in terms of appearance is very interesting, b) all menus, icons, and navigation buttons have a consistent function, c) it looks good, so that makes students happy in learning. So this research is feasible and reasonable because it does not contradict the theory. The implementation of packet tracer learning media can still be continued for the next year instead of the limited facilities and infrastructure of network practice in school.

In addition to packet tracer media proven to be useful for implementation in CDN learning, teachers can also implement Procedural Content Generation (PCG) that offers the potential to isolate, identify and categorize simple or complex action in a game by placing it in a meaningful pattern and interpreted to guide decision-making [25]. The PCG has also proven effective in educating and cultivating early English skills for children [26].

IV. CONCLUSIONS

The result of evaluation packet tracer learning media on design computer networking subject for students of Grade XI CNT in Public vocational high school No, 1 Painan, West Sumatera Indonesia can conclude that the effectiveness of the use of learning media with packet tracer is in the high category that is 82.76%. It means that the effective learning media is applied in learning design computer networking after reviewing of 3 aspects of learning media quality, and this study feasible and reasonable because it is not contrary to the theory and implementation of packet tracer. This packet tracer media can still be continued for the next year instead of the limitations of network practice facilities and infrastructure in schools.

REFERENCES

- [1] Flew, T, *New Media an Introduction*. Oxford: University Press, 2014.
- [2] Fajriah, Ulfah Nur; Madziatul Churiyah, Utilizing Instructional Media for Teaching Infrastructure Administration, *Journal of Education and Practice*, Vol.7, No.6, 2016.
- [3] Jalinus, Nizwardi; Ambiyar, *Media Pembelajaran dan Sumber Belajar*, Jakarta: Kencana, 2016.
- [4] Orey, Michael; Branch, Robert Maribe (Eds.). *Educational Media and Technology Yearbook*, Volume 39. London, Springer International Publishing, 2015.
- [5] Heinich, R. et al. *Instructional Media and Technologies for Learning*. New Jersey: Prentice-Hall, Inc, 2008.
- [6] Stosic, Lazar. The Importance of Educational Technology in Teaching, *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE)*, Vol. 3, No.1, 2015.
- [7] Hooshyar, D., Ahmad, R. B., Yousefi, M., Yusop, F. D., & Horng, S. J. A flowchart-based intelligent tutoring system for improving problem-solving skills of novice programmers. *Journal of Computer Assisted Learning*, 31(4), 345-361. 2015.
- [8] Hooshyar, D., Ahmad, R. B., Yousefi, M., Fathi, M., Horng, S. J., & Lim, H. (2016). Applying an online game-based formative assessment in a flowchart-based intelligent tutoring system for improving problem-solving skills. *Computers & Education*, 94, 18-36.
- [9] Murtado, Hidayat, *Evaluasi Penggunaan Media Pembelajaran Packet Tracer Terhadap Hasil Belajar Siswa Jurusan Teknik Komputer Jaringan (TKJ) Menggunakan UTAUT Pada SMK Negeri 2 Palembang*.: Universitas Palembang, 2015.
- [10] Stéphane Crozat, Olivier Hû, Philippe Trigano, *A Method for Evaluating Multimedia Learning Software*. IEEE International Conference on, Volume: 1. Retrieved from DOI: 10.1109/MMCS.1999.779287, 1999.
- [11] Nesbit, J. C., & Li, J. (2004). *Web-based tools for learning object evaluation*. Proceedings of the International Conference on Education and Information Systems: Technologies and Applications, 2, 334-339, 2004.
- [12] Javid, Sheikh Raashid. (2014). Role of Packet Tracer in learning Computer Networks. Retrieved from: *International Journal of Advanced Research in Computer and Communication Engineering* Vol. 3, Issue 5, May, p. 6508-6511, 2014.
- [13] Seels, B. B., & Richey, R. C. *Instructional Technology: The Definition and Domains of the Field*. Washington: Association for Educational Communications and Technology, 1994.
- [14] Orey, Michael; Branch, Robert Maribe (Eds.). *Educational Media and Technology Yearbook*, Volume 40, London, Springer International Publishing, 2017.
- [15] Hatry, Harry P; Newcomer, Kathryn E; Wholey, Joseph. *Handbook Practical Program Evaluation*, London: Sage Publication, 2015.
- [16] Jasin, Leonard A; Glenwick, David S. *Qualitative, Quantitative, and Mixed Methods*. New York: Oxford University Press, 2016.
- [17] Edmonds, W. Alex; Kennedy Thomas D, *An Applied Guide to Research Quantitative, Qualitative, and Mixed Methods*, London: Sage, 2017.
- [18] Willis, Gordon B, *Analysis of the Cognitive Interview in Questionnaire Design*, New York: Oxford University Press, 2015.
- [19] Ravitch, M Sharon; Tisdell, Elizabeth J, *Qualitative Research, A Guide to Design and Implementation*, San Fransisco: Yossey-Bass, 2016.
- [20] Saldana, Johnny, Matt Omasta, *Qualitative Research: Analyzing Life*. California: Sage Publications, 2017.
- [21] Moleong, Lexy. J, *Metodologi Penelitian Kualitatif (Edisi Revisi)*. Bandung: PT. Remaja Rosdakarya, 2017.
- [22] Freeman, Melisa, *Modes of Thinking for Qualitative Data Analysis*. New York: Routledge, 2017.
- [23] Arsyad, Azhar. *Media Pembelajaran*. Jakarta: PT Rajawali Pers, 2016.
- [24] Ibrahim dan Nana Syaodih. 2010. *Perencanaan Pengajaran*. Jakarta: Rineka Cipta.
- [25] Hooshyar, D., Yousefi, M., & Lim, H. Data-Driven Approaches to Game Player Modeling: A Systematic Literature Review. *ACM Computing Surveys (CSUR)*, 50(6), 90. 2018
- [26] Hooshyar, D., Yousefi, M., Wang, M., & Lim, H. A data-driven procedural-content-generation approach for educational games. *Journal of Computer Assisted Learning*. 2018