

Predicting dependency level in dyadic friendship

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Abstract

This study aims to (1) investigate the dyadic friendship domain and (2) test it as a predictor of a friendship dependency level. The study was conducted in two stages: Study 1 and Study 2. Study 1 explored four friendship domains by using an indigenous psychological approach. Study 2 predicted the dyadic codependency level based on the finding of Study 1 by implementing an Artificial Neural Network (ANN) with a Multilayer Perceptron (MLP) model conducted in 25 experiments (5 hidden layers x 5 epochs). Data collection was carried out using five open-ended questions and one closed-ended question in Study 1; and the Investment Model Scale adaptation questionnaire (13 items; $\alpha = 0.832$) in Study 2. Study 1 and Study 2 were conducted at a time on 268 respondents (52 male, 216 female). The finding of Study 1 showed that friendship starts from: (a) the initial contact, which was based on the proximity factor (48.51%), (b) closeness, which was based on personality factors (36.19%), (c) the most frequent activities carried out together in the form of hanging out (52.61%), and (d) the reason for fear of losing a partner due to personality factors (29.48%). Study 2 revealed that friendship dependency level can be predicted by four friendship domains with an accuracy level of 58.35%, in which the initial contact and joint activity domain was of higher importance than the two others (epoch = 5000; hidden layer = 4 units). The overall findings showed that the dyadic codependency level not only can be calculated after friendships are formed and developed but also can be predicted from the initial stages of a relationship when acquaintanceship occurs.

Keywords

artificial neural network, dependency, friendship, indigenous psychology

Introduction

Friendship is universal despite the cultural limitation (Woods et al., 2013), generation (O'Dare et al., 2017), disability (Nurjaman & Faturochman, 2018), race, and gender (Galupo & Gonzalez, 2013). Friendship is a communal relation based on sincerity characterized by suitability, togetherness, and support as its characteristics (Faturochman & Nurjaman, 2018). This relationship is included as an expressive pattern that focuses on the emotional aspect, especially in women, and the instrumental aspect, which is more in men, a relation of which is more to general activities than emotional expression (Dwyer, 2002). Friendship is usually established based on common activities Radmacher & Azmitia (2006), similarity (Bahns et al., 2019; Ilmarinen et al., 2016; Linden-Andersen et al., 2009), proximity (Preciado et al., 2012; Rivera et al., 2010), and frequent contact (Wissink et al., 2009).

Friendship generates psychological benefits, such as increased psychological well-being (Bagci et al., 2018; Dunbar, 2018) but also causes relationship risks, such as trust-breaking (Anatassia & Faturochman, 2017). According to equity theory, an individual considers the equivalence between what an individual has given and would receive from the relationship. Thus, when the output degree does not equal his/her investment, it will create a feeling of being exploited (Dwyer, 2002). When this situation occurs, there are three options as a response. The first option is the actual equity restoration by the individual who reacts accurately and convinces himself that his friend is doing the same thing. The

second option is psychological equity restoration by making a negation toward disequilibrium of benefits from the friendship. This situation refers to an individual who convinces himself that what he gets from a friendship is equal to what his friend's, a condition that can be achieved by using illusive thoughts to eliminate any inequality in friendship. The third option is setting aside friendship by both parties as they can no longer restore the friendship equity. This situation does not always imply separation in friendship as one of the parties only tends to put aside the emotional aspect of his/ her friend (Hatfield & Rapson, 2012).

At the cognitive level, a relationship develops through three stages. The first stage is cognition as the establishment of individual mental representation in a relationship through beliefs and values. The second stage is cognitive structure by explaining individual complexity and cognitive accessibility as a relationship unit. The third stage includes the cognition process to determine the individual satisfaction degree toward the relationship based on social comparison, derogation alternatives, selective attention, rationalization, and temporal comparison (Karney et al., 2003). The process starts with the identification process of ideal couples and relationships.

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An ideal partner is identified based on (a) the partner's characteristics and relevance in the aspect of intimacy, trust, and loyalty; (b) the partner's personality and appearance based on the degree of attractiveness, energy, and health; and (c) social characteristics of the partners and resources. At the same time, an ideal relationship is identified based on (a) the degree of intimacy, loyalty, and relationship stability; and (b) the degree of happiness and desire significance in a relationship (Simpson et al., 2003).

Six determinants lead one into a friendship zone: proximity, similarity, physical attraction, reciprocal, complementary, and competence. (Dwyer, 2002). The proximity factor only brings two or more individuals together through passive contact; thus, one of the parties must initiate the communication to establish a friendship as an interpersonal relationship (Gilovich et al., 2011). According to Berscheid & Ammazalorso (2003), the interpersonal emphasis lies in interaction. Two individuals interact with each other when both sides impact each other. This situation leads to an understanding that a relationship is an oscillation of impact between persons in an interaction (interdependent). Rusbult et al. (2012) stated four significances of interdependent study in an interpersonal relationship. The first is that interdependent shapes daily interaction. The pattern describes the obstacles and opportunities to detect interactions whose characteristics are harmonious, contradictory, or exploitative. The second significance is that interdependent forms individual mentality – cognitive and affection, which reflect its meaning and identify the behaviour that will appear in a similar situation. The third significance is establishing a relationship. Interdependency describes the options and limitations in a relationship identified through commitment, trust, authority, and conflict. The fourth significance is that interdependency forms one's self. An individual develops preference stability, motives, and behavioral tendency as adaptation consequences towards the interdependence situation. In friendship concept, Nurjaman (2018) explained that the interdependent pattern can be identified from the initial stage of introduction, which is the availability and sympathy tend to refer to independent relationship; while at the same time. the willingness and attractiveness tend to lead to interdependent relationship.

Van Lange & Rusbult (2012) explained four frameworks as the basis of the interdependency theory. The first is the structural principle to understand psychological processes, such as motivation, cognition, affection, behaviour, and social interaction. These features are formed within situational taxonomies, including dependency level, dependent mutualism, dependent basis, interest covariant, temporal structure, and information availability. The second is the transformation principle referring to the psychological process established based on the interaction goals, the goals of which can be strengthened through the affection, cognition, and motivation processes. In this context, social interaction can become a transformation sector manifested when an individual assesses the consequences of their behaviours. The third is the interaction principle seen as a function of two individuals (A and B) within a situation (S) formulated as $I = f(A, B, S)$. This situation can activate A and B's motivation, affection and cognition as individuals in the relationship. When this occurs, both sides' reaction becomes mutual, creating a particular interaction pattern. The fourth is the adaptation

principle as a result of social interaction repetition reflected by the orientation stability in the transformation pattern. This adaptation causes different orientations between the couple and situation, individual interaction, and at the same time, interaction with a specific partner and social norms of the individual as a part of a particular society.

The structure of an interdependent situation can be reviewed through the dependency level. This level describes the dependency degree between the partner based on the behavioural effect degree towards him/her. When an individual realizes that his/ her partner's behaviour does not determine the result, this individual is considered independent (Rusbult et al., 2003; Van Lange & Rusbult, 2012). Further, the independent, dependent, and interdependent relationship patterns can manifest in friendship interaction, such as mutual activity, story sharing, and social support (Nurjaman, 2016).

In friendship, the dependency level relies on the high level of relational satisfaction, the low quality of alternative relations, and the high level of relational investment. First, relational satisfaction shows the experience level of positive and negative affection regarding involvement with the partner in the relationship. The second is the quality of alternative relations that express the availability of other relationships besides the current friendship, such as close friends, boyfriend/girlfriend, and family. The third is investment assessment, which shows the sacrifice degree of individual resources transformed into mutual resources in the friendship (Rusbult et al., 2012). These three psychological processes align with an interdependency study explaining that an individual becomes dependent in an asymmetrical relation based on the subjective aspect of love and commitment and the differences in material resources distributed in an investment (Kelley et al., 2003).

The above description indicates that dependency levels can be identified through friendship. Thus, Study 1 will explore themes from the four domains of friendship, namely introduction, closeness, joint activities, and the fear of losing a partner. Study 2 will test the finding in Study 1 as the predictor toward the dependency level in dyadic friendship consisting of relationship satisfaction, alternative relationship quality, and relational investment assessment.

Method

Study 1

This study's respondents were Undergraduate Psychology students of Universitas Teknologi Yogyakarta. Three hundred twenty respondents filled out the questionnaire. Two of them were not included in the analysis as one of their answers was the absence of fear of losing their friend. Thus, the total number of respondents was 268 consisting of two male and 216 female students. The data collection was by an open-ended question in the form of a questionnaire based on the study theme and was arranged online using Google Forms. The questionnaire on the friendship domain consisted of five open-ended questions (primary) and one closed-ended question to eliminate the respondents: (1) Who is your closest friend currently? [initial is allowed] (2) How did you first meet and get to know each other? (3) Mention three things that make your relationship close! (4) Name three things that you two do together! (5) Are you afraid of losing your

friend? [Yes/No] (6) Why are you afraid of losing your friend? The qualitative data were analyzed using content analysis that includes open coding, axial coding, and selective coding, aiming to explore indigenous themes from the four friendship domains (Faturachman et al., 2017).

Study 2

The data collection of Study 2 was conducted at a time with Study 1, meaning that the number of respondents' characteristics is equal. Friendship dependency was carried out using an adaptation scale from the Investment Model Scale (IMS) (Rusbult et al., 1998), which consists of three aspects: (1) five items of rational satisfaction, (2) five items of alternative relationship quality, and (3) five items of rational investment size. This scale used a Likert Scale applying the interval 1-4 (1= absolutely inappropriate; 2= inappropriate; 3= appropriate; 4= absolutely appropriate). The sum of these three aspects resulted in friendship dependency scores taking into account that the score of the alternative relationship was reversed. It deals with a dependency when rational satisfaction and investment size are high while the quality of alternative relationships is low. Referring to the validation test results, which also count the relationship quality aspect, items 8 and 9 did not meet the standard due to being smaller than 0.3. The disposal of these two items obtained the coefficient of Cronbach's Alpha increased from 0.8 to 0.832. The interval dependency score was then transformed into nominal data between high level ($X > M$) and low level ($X < M$) based on the average value of dependency ($M = 35.26$; $SD = 4.506$).

In Study 2, the results of Study 1 were applied as the predictor of the friendship dependency level by implementing the Artificial Neural Network (ANN) with a Multilayer Perceptron (MLP) model. To obtain the best predictive model, this present study was conducted in 25 experiments of ANN by setting the configuration of the hidden layer (2, 4, 5, 6, and 7 units) and the epoch (1000, 2000, 3000, 4000, and 5000 epochs). The total sample was divided into 70% for training and 30% for testing.

Result

Study 1

In the open coding code stage, responses for the initial contact and fear of loss domains were in the form of descriptive, while for the closeness and joint activity domains were short words consisting of three short answers each. Descriptive responses were analyzed by identifying the first short sentence, while subsequent sentences were ignored. Moreover, the axial coding stage consisted of 58 subthemes in those four domains: nine initial contacts, 20 closeness, 11 joint activities, and 18 fear of loss. All these subthemes were categorized in the process of selective coding resulting in eight main themes in each domain and five main themes in joint activity. Table 1 presents the main themes percentage of four friendship domains.

Study 2

The dependency levels were categorized into low (nominal score of 0) and high (nominal score of 1). However, the dependency level (output layer) was predicted by the

input layer consisting of four factors, namely initial contact (nominal score of 1-8), closeness (nominal score of 1-8), joint activity (nominal score of 1-5), and fear of loss (nominal score of 1-8). The ANN experiments were conducted 25 times for each configuration, involving hidden layers (3, 4, 5, 6, and 7 units) and epochs (1000, 2000, 3000, 4000, and 5000 epochs). These experiments resulted in the lowest ANN accuracy rate of 49.35%, and the highest reached 58.35%. The best ANN model with the highest accuracy occurred at the configuration of the 4th unit of the hidden layer and 5000 epoch.

Based on Figure 1, the ANN model was relatively more accurate for predicting a low dependency level than a high one. It can be seen from the first boxplot (far left of the graph), which was slightly relative above 0.5, showing the accuracy between observation and predicted results at a low dependency level. Moreover, the ROC (Receiver Operating Characteristics) curve showed 0.58 areas below the curve at high and low dependency levels. This indicated that ANN model for predicting dependency level based on four friendship domains was not good enough because the ROC curve was at a value interval of 0.5 (fail) to 1 (perfect).

The experiment implemented the activation function of the Sigmoid hidden layer and Softmax output layer because the dependent variables were nominal: high and low dependency.

Figure 2 presents the best ANN model with an accuracy level of 58.35%, consisting of 4 units of the hidden layer. Based on this model, the domain of initial contact became the independent variable with the highest importance value of 0.426 (100%). That was then followed sequentially by the joint activity domain, which reached 0.271 (63.5%), closeness at 0.167 (39.3%), and fear of loss at 0.136 (31.8%).

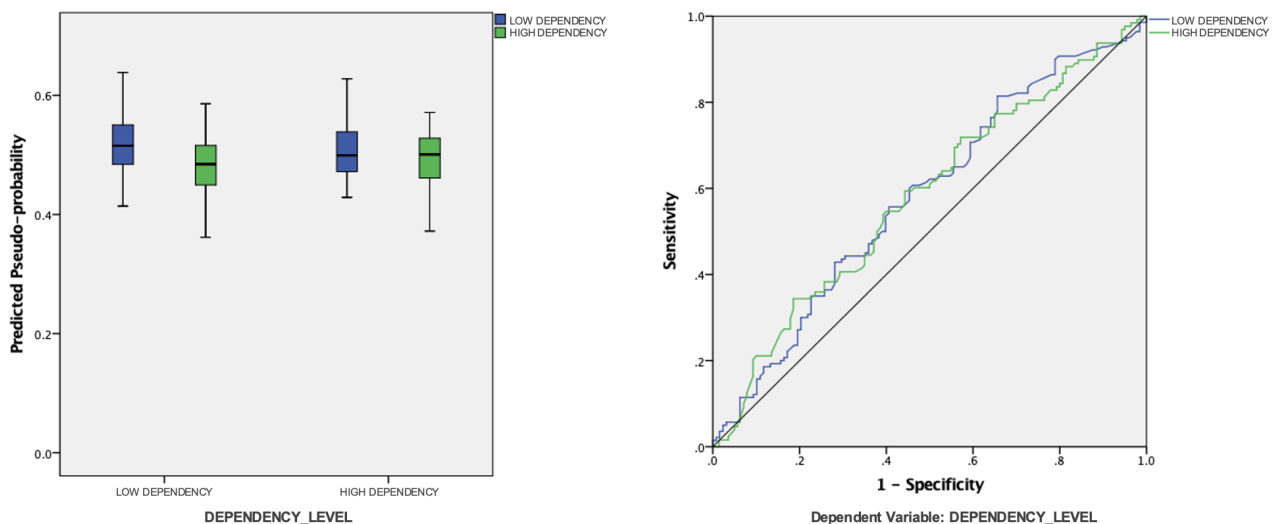
Discussion

Study 1 showed that dyadic friendship originated from the initial contact between one party and their relationship partners. Various factors could initiate this meeting to thus the initial contact or introduction part, most of which included factors of proximity and similarity. This is in accordance with what has been conducted by Preciado et al. (2012), which finds that geographical proximity is a more important factor in building friendships instead of maintaining them. Nevertheless, proximity requires one of the parties to initiate the contact, which leads to friendship because proximity is only limited to opening passive contact (Gilovich et al., 2011). Likewise, proximity can increase the chance of interaction, so introductions are likely to happen (Batool & Malik, 2010; Rivera et al., 2010). In addition, similarity directs to the feeling of liking each other (Ilmarinen et al., 2016), making it easier for individuals to build new relationships with others (Bahns et al., 2019; Batool & Malik, 2010). Regarding sex differences, men have a higher frequency of contact (Wissink et al., 2009) and perceive similarities with their partners (Linden-Andersen et al., 2009). Despite the fact that this present study did not examine the difference of proximity and similarity based on sex, the number of respondents involved was mostly women reached the percentage of 80.6% of the total.

In the initial contact domain, proximity became the most experienced factor (48.51%) because of the geographical

Table 1. Theme Categorization Final Results (N=268)

Friendship Domain	Category	Total	Percentage
Initial Contact	Proximity	130	48.51%
	Similarity	59	22.01%
	Motivational	28	10.45%
	Accidental	26	9.70%
	Others	25	9.34%
Closeness	Personality	97	36.19%
	Similarity	80	29.85%
	Concord	29	10.82%
	Proximity	26	9.70%
	Social Support	19	7.09%
	Others	17	6.34%
Joint Activity	Hanging out	141	52.61%
	Sharing stories	52	19.40%
	Joint Activities	37	13.81%
	Doing hobbies	25	9.33%
	Others	13	4.85%
Fear of Losing a Partner	Personality	79	29.48%
	Irreplaceable	54	20.15%
	Social Support	41	15.30%
	Comfort	35	13.06%
	Used to being together	34	12.69%
	Others	25	9.33%

**Figure 1.** Prediction-Observation Graph and Dependency Level ROC Curve

proximity between the respondents and their partners, such as entering the same school.

We first met at kindergarten, entered the same school, and lived in the same complex. So, we always spend time together both at school and at home. (NM-R83)

Further initial contact factor was the similarity or the commonality that the respondents and their partners had so that the two get acquainted, such as being equally active in the organization. Motivational factors occurred when respondents had the motive to initiate a conversation, such as asking about the course a person who is now a friend. These factors might include face-to-face and online through social media. The initial contact conducted online aimed to find a friend partner, such as getting acquainted on Instagram and then continuing on WhatsApp. On the other hand, an accidental

factor made respondents acquainted with their friend partner through certain events, such as by chance meeting at an event.

Another introductory factor included personality and interference. Personality refers to the personal quality of the partners; for instance, the initial meeting makes the respondents feel their partners are fun. Whereas the interference factor occurred due to the interference of others; for example, their parents frequently meet.

At first, I thought this person was chubby, unfriendly; but it turned out different after knowing him enough. He is kind and fun. He also wants to play and hang out together. We have once also merged into the same organization. (D-R109)

Moreover, in the domain of closeness, personality was the most experienced factor for the respondents (36.19%). This

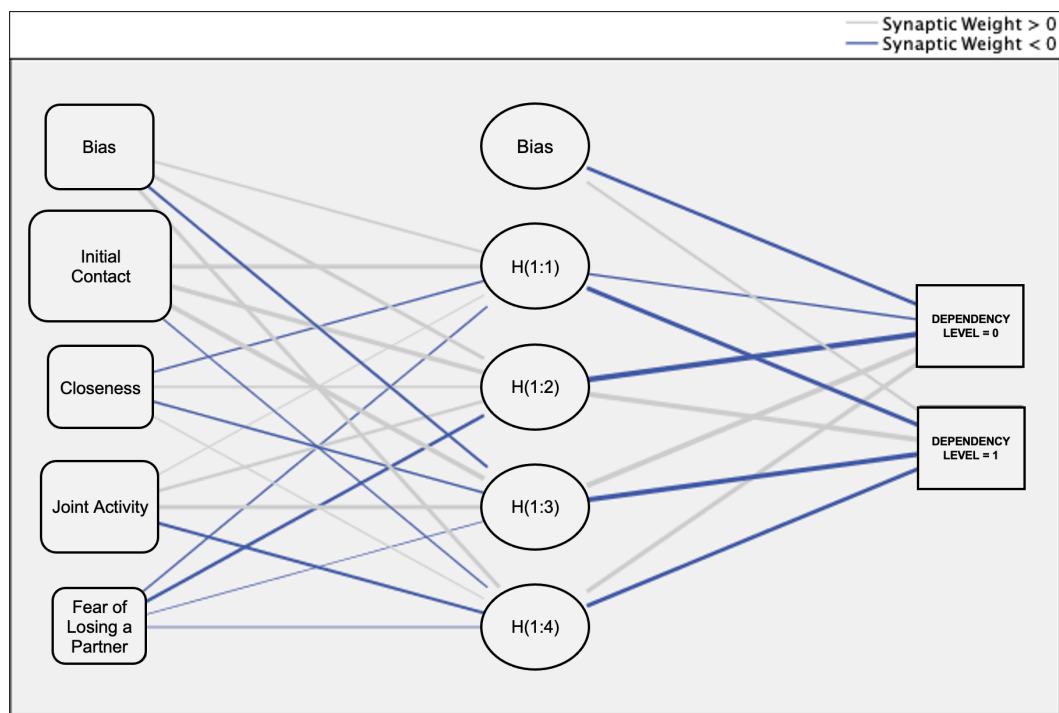


Figure 2. ANN Architecture Model with Best Dependency Level Accuracy

factor represented the personal quality of the partner, such as caring, understanding, open, accepting, friendly, trustworthy, or even ridiculous. Another factor was similarities like hobbies and habits. This factor created a close relationship because they felt matched, connected, and complemented each other. However, proximity occurred as geographical proximity happened. Some respondents admitted these as a factor that brought their relationships closer. The other factors were manifested in various ways, such as sharing stories, getting used to being together, and giving help or reminding each other.

The emergence of closeness in a relationship was motivated by various factors, which in this case was personality. Based on the findings, personality was the personal quality of a relationship partner which not only strengthened friendships, but also served as the primary cause of people's fear of losing their partners. This was consistent with earlier studies showing that, in addition to relationship and time factors, one of the elements influencing friendship closeness is personal quality (Anatassia & Faturochman, 2017). According to the notion of the big five personality traits, agreeableness and neuroticism consistently influence the development of friendships, both in building and maintaining relationships. Contrarily, extraversion, conscientiousness, and openness are personality traits that promote friendship development but have erratic effects (Harris & Vazire, 2016). Individuals with high agreeableness tend to form longer friendships, maintain closeness with friends' partners, and spend more time with friends (Laakasuo et al., 2016).

Hanging out (52.61%), whether for eating, hanging out, or traveling together, was the activity that respondents most commonly did with their partners. Sharing stories was another activity that the respondents and their partner frequently engaged in together. The term "joint activities" could refer to both productive and non-productive activities, such as going

back and forth to university and studying together. In addition, other joint activities were in the form of shared hobbies, such as playing futsal or fungirling.

In the fourth friendship domain, as many as 29.48% of the total respondents admitted that they were afraid of losing their partners for personality reasons. These occurred when the respondents felt that their partners could understand their condition and were ready to accept them for who they were.

Considering that he is a buddy of mine who is aware of my emotions in both joyful and sad times. Due to the fact that he views himself as family, he has no sense of shyness. He's an upbeat individual who enjoys making me feel better when I'm depressed. He never interrupts me and pay attention to what I say. (N-R142)

He's like a brother to me. So, if he is sad, even if it is not my fault, I feel like a failure as a friend. As much as I could, I want to be a best friend as well as a brother for him. (A-R57)

Among the causes of fear of losing a partner were irreplaceable factors. For instance, the respondent felt that they were already close, comfortable, and affectionate; there were reasons for convenience, such as the fact that the respondent used to do things with his partner; there were reasons for fear when the respondent must be alone, such as the fact that his friend's partner was a place to vent and share stories; and there were reasons for convenience.

According to this study, hanging out, sharing stories, joint activity, and engaging in hobbies were the most popular activities done with partners. Hanging out and sharing stories were the most shared activities. This is consistent with the earlier study, which found that dyadic friendships often involve joint activities like hanging out, sharing stories, and

providing social support (Nurjaman, 2016). In fact, another study suggests that friendship formation, particularly among men, is influenced by group activities (Radmacher & Azmitia, 2006). The degree of privacy of the information shared by individuals with their partners can be used to view the friendship activity of self-disclosure (Nurjaman, 2016). In addition, the quality of friendship also determines the pattern of self-disclosure in friendship, both in intracultural and intercultural friendships. Even though people will share more common information with their cross-cultural partners than with their intracultural friends, this difference also depends on the quality of partners (Chen & Nakazawa, 2016).

Furthermore, in study 2, the findings showed that the four dyadic friendship domains could predict the level of dependency with an accuracy of 58.35%, with the introduction factor as the most important domain in the ANN model. The level of dyadic friendship dependency can be seen from friendship satisfaction, quality of alternative relationships, and investment size (Rusbult et al., 2012). Based on previous studies, dependency on friendship can be identified at the beginning of friendship formation, not based on proximity and similarity factors, but rather availability and sympathy factors which tend to lead to independent relationships; as well as willingness and interest factors that tend to lead to interdependent relationships (Nurjaman, 2018). Kelley et al. (2003) explain that at first individuals are faced with a dilemma situation between autonomy which leads to independent relations and closeness which leads to interdependent relations, which can appear alternately in the early stages of the relationship development. Both the proximity and similarity factors, which account for a large percentage of the introductory domain in this study, determine increased interpersonal interest at the start of friendship (Batool & Malik, 2010; Rivera et al., 2010). This happens because the proximity factor has a greater effect on the formation of friendship relations than as a factor of friendship survival (Preciado et al., 2012).

The friendship closeness domain in this study made a smaller contribution than the introduction and joint activity domains to the level of dependency in the ANN model. Based on the dependency-regulation model, individuals can regulate the degree of closeness and not let them become dependent on their relationship partner before believing that the relationship partner is experiencing the same thing (Kelley et al., 2003). Rusbult et al. (2008) explained that proximity as a unit of analysis for the degree of dependency is a continuum, from the lowest degree to the highest degree. This indicated that the factors of personality, similarity, and compatibility which have a high percentage in this study, are continuum in determining the level of dependency.

The joint activity domain was the second most important factor for predicting the level of dependency in the ANN model, which consisted of hanging out and sharing stories as the two highest percentages. Nurjaman (2016) offered three models of joint activity as manifestations of friendship interdependence, namely accidental, interference, and pure models. The accidental model was based on situational motives and the interference model was based on personal motives leads to a pattern of independent relations. Meanwhile, the pure model was based on interpersonal motives, thus directing friendship to

interdependent relationship patterns. This indicated that the level of dependency on dyadic friendships can be predicted through joint activities such as hanging out and sharing stories, by examining the motives behind these joint activities.

Joint activities in the form of sharing stories reflect the openness to share information from individuals to their partners. According to Laurenceau et al. (2008), openness (self-disclosure) is verbal communication about personal relevant information, thoughts, and feelings conveyed to other individuals and has the potential to develop intimacy. More specifically, emotional openness is more effective in developing intimacy than factual openness which only contains personal information. Emotional openness indicates a desire to be known, understood, and accepted by a relationship partner. In this study, the feeling of being understood and accepted by a partner is a sub-theme of personality as one of the domains for fear of losing a partner. This indicates a link between joint activities in the form of sharing stories and personality, in the form of a feeling that his partner can understand his condition, is understanding, and is willing to accept him for who he is.

In other contexts, personal information as material in sharing stories can also be viewed from the depth and breadth of personal information. This is needed to measure the pattern of sharing stories (confits) in friendship: Is the information that is the material of the vent private or public? (Baumeister & Vohs, 2007). When individuals are open to investing in private information, it tends to increase dependency on friendship. Conversely, if information is superficial or general, then individuals tend to have low dependency or not depend at all on friendship (Nurjaman, 2016). Kelley et al. (2003) explained that information disclosure and personal secrets reflect whether individuals wish to increase the degree of dependency or not on relationships. However, the volume of investment is not only measured by calculating personal information alone, but can also take the form of the capacity and significance of personal resources (Rusbult et al., 2012).

Conclusion

The findings revealed eight themes in the domains of introduction, closeness, and reasons for fear of losing; as well as five themes in the domain of shared activity. The domain of introduction is mostly motivated by the proximity factor. The domains of closeness and the reason for fear of losing a friend's partner are mostly due to personality factors. Meanwhile, hanging out is the most frequent activity in the domain of joint activity. Following 25 ANN experiments, it is discovered that the ANN model with a configuration of 4 hidden layer units and 5000 epochs performed better in predicting the degree of dependency among the four friendship domains, with a prediction accuracy of 58.35%. Since the dependent variable is derived from many indigenous friendship themes, it is expected that the ANN model's level of accuracy is insufficient despite its ability to predict the level of dependency. Therefore, further studies shall specify the psychological aspects of friendship to explore indigenously when they are employed as the dependent variables in the ANN model.

The implementation of ANN in the studies of psychology is relatively few. Such irrelevance is due to the lack of supporting references and needs to be examined.

Declarations

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Author contributions

The author conducted the entire study involving literature studies, data collection, data processing, data analysis, reporting, and publication.

Conflict of interest

The author had no conflict of interest in the implementation, preparation and publication of this study. The study was conducted in 2019 before the COVID-19 pandemic in Indonesia.

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